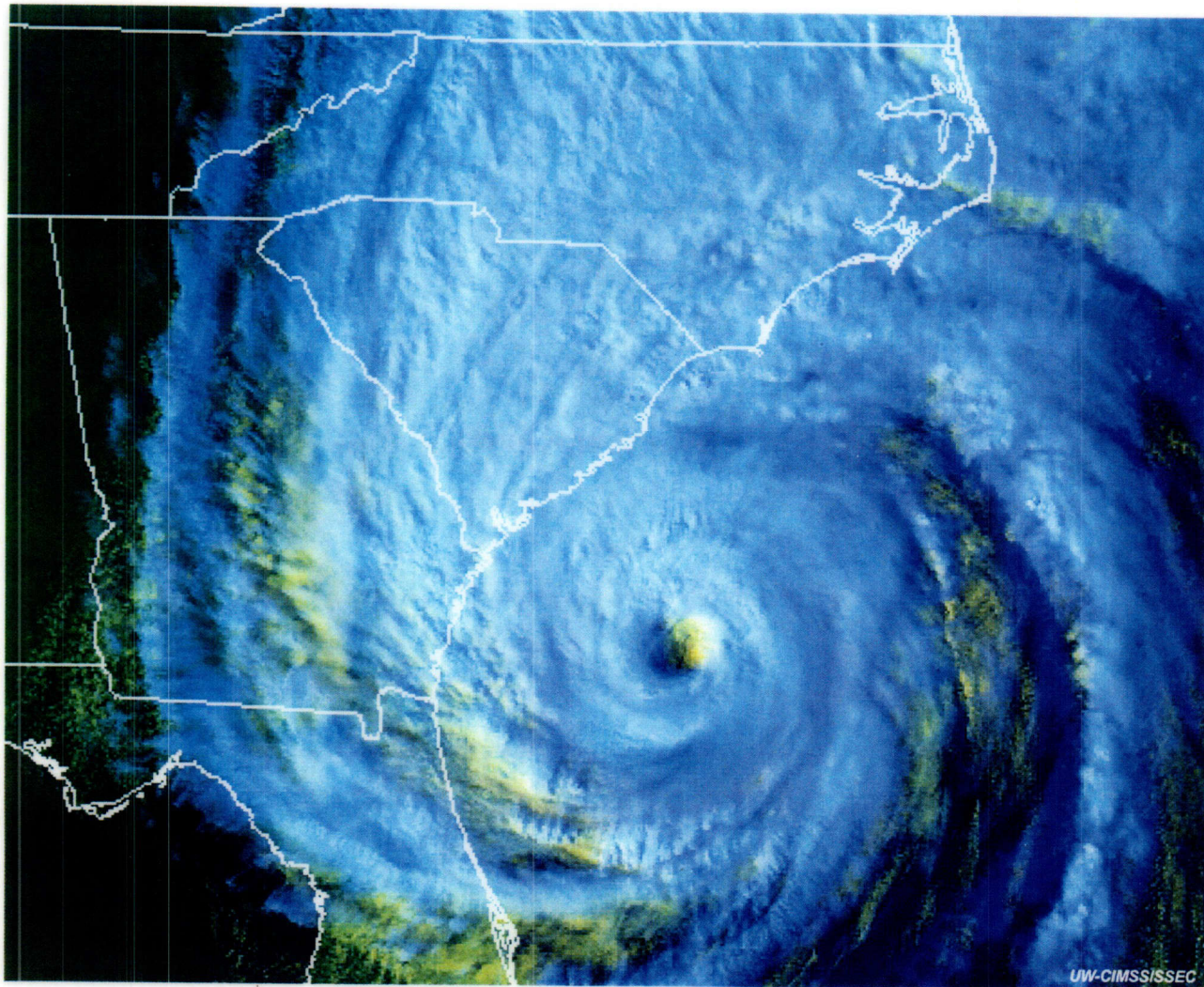
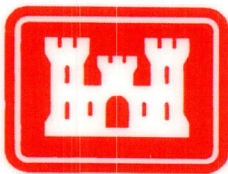


Hurricane Floyd Assessment

***Review of Hurricane Evacuation Studies
Utilization and Information Dissemination***



May 2000



**US Army
Corps of Engineers**



HURRICANE FLOYD ASSESSMENT
Review of Hurricane Evacuation Studies Utilization
And Information Dissemination

Prepared for

U.S. Army Corps of Engineers
Savannah District
And
Federal Emergency Management Agency
Region IV

Prepared by

Post, Buckley, Schuh & Jernigan, Inc.
1901 Commonwealth Lane
Tallahassee, Florida 32303

May 2000

090857.00

00945

TABLE OF CONTENTS

Chapter	Title	Page
	List of Tables/List of Figures	ii
	Executive Summary	iii
1	Introduction	1-1
2	Hazards/Vulnerability Data	2-1
3	Behavioral Analysis - Public Response in Floyd	3-1
4	Shelter Issues	4-1
5	Transportation/Clearance Time Data	5-1
6	Evacuation Decision Making	6-1
7	Public Information	7-1

APPENDICES

Appendix	Title
A	Meeting Attendees/Persons Providing Input In Affected Areas
B	National Hurricane Center's Hurricane Floyd Warning Summary/Timetable and Best Track Data
C	Hurricane Behavioral Floyd Response Questionnaire
D	Evacuation Behavioral Data by Interviewed Area
E	Traffic Count Summaries by State

LIST OF TABLES

Table	Title	Page
4-1	Public Shelter Data Summary	4-2
5-1	Transportation/Clearance Time Data Summary	5-2
6-1	Evacuation Decision Process Data	6-2

LIST OF FIGURES

Figure No.	Title	Page
2-1	Observed Maximum Storm Surge Heights For Hurricane Floyd	2-3
2-2	Hurricane Floyd Water Levels	2-4
2-3	Hurricane Floyd Precipitation and Crest Information for North Carolina and South Carolina	2-6
5-1	Directional Traffic Count Data - Duval County Station 109 I-10 (westbound)	5-19
5-2	Directional Traffic Count Data - South Carolina Station 20 I-26 (northbound)	5-21

Executive Summary

In September 1999, Hurricane Floyd threatened the eastern coastline of the United States from Florida to North Carolina causing a massive evacuation. Hurricane Floyd, a strong Category 4 hurricane, headed north along the Florida coast turning on a north westward course, while slowly weakening. On September 16, 1999, Floyd made landfall near Cape Fear, North Carolina as a Category 2 hurricane. Floyd caused over 3 million people to evacuate, and up to 18 inches of rain in North Carolina.

Hurricane Floyd provided an opportunity to answer several key questions regarding major FEMA/Corps hurricane evacuation study planning efforts:

Did local and state officials use the products produced in these major studies?

Were study data regarding storm hazards, behavioral characteristics of the threatened population, shelter information, evacuation times, and decision making accurate and reliable?

Which study products were most useful and which least useful - what improvements could be made to current methodologies and products?

To answer these questions, study teams consisting of representatives from FEMA, the U.S. Army Corps of Engineers, and Post, Buckley, Schuh & Jernigan, Inc. visited with local and state officials throughout the directly impacted areas of Florida, Georgia, South Carolina and North Carolina.

Interviews and analysis conducted during the post-Floyd effort revealed heavy evacuation participation rates on the part of permanent population and tourists throughout the study areas.

Major recommendations from this post-Floyd effort include:

1. Build an inland flooding component into the HES process using the ongoing North Carolina Hurricane Evacuation Restudy as a starting place.
2. Continue to refine the development of storm tide mapping, automating line delineation while lowering study production costs.

3. Use the Internet as a tool for disseminating storm surge mapping information as Wilmington District has done in creating "ncstormsurge.com."
4. Continue to use post storm assessments as the primary tool for providing behavioral data to the HES process.
5. Run scenarios with higher out-of-county evacuee percentages for strong storm clearance time calculations.
6. Capitalize on the behavioral finding by HMG that the public is willing to try phased evacuations and alternative highway routes if instructed by government officials.
7. Hold meetings to discuss ways in which the public's response/behavior can be changed through media messages so that highway congestion can be lessened.
8. Reduce public shelter percentages in the transportation analysis so that demand estimates are more realistic.
9. Examine public shelter locations for vulnerability to freshwater flooding.
10. Provide training/preparedness of non-American Red Cross personnel to provide shelter assistance during an evacuation.
11. Increase awareness of public shelter locations for local population prior to a hurricane season.
12. Improve communication of shelter locations and opening and closings throughout an evacuation.
13. Provide pre-season preparedness in Spanish for areas with large population of Hispanics, particularly rural areas.
14. Provide Spanish-speaking shelter personnel for those areas with large population of Hispanics.
15. Use rest stops and visitor information centers as information dissemination points for evacuees en route.
16. Provide generators to shelters due to the high number of shelters with loss of utilities.
17. Increase security at shelters in North Carolina that reported problems due to shelters being opened for extended periods of time.

18. Improve communications with evacuees while en route by providing traffic information at rest areas or through radio.
19. Provide a tool to help emergency managers anticipate evacuation traffic coming from other jurisdictions or states.
20. Work with each state's DOT to provide local emergency managers "real-time" traffic count information.
21. Calculate and report worst household commute times in addition to clearance times for each storm scenario.
22. Run clearance time calculations for reverse lane operations.
23. Provide traffic condition thresholds which would trigger implementation of various traffic control alternatives.
24. Work with USDOT and the state DOT's to implement ITS to facilitate evacuations.
25. Run clearance time scenarios with larger out-of-county percentages and greater participation of inland counties.
26. Conduct more training sessions with local EMS' regarding the HURWIN 95 model.
27. Develop a rainfall forecasting component to HURWIN 95.
28. Enhance INLAND WINDS model to better predict wind fields.
29. Encourage NOAA to work on models to improve the wind field forecasting.
30. Explore possibility of adding real-time traffic count information to HurrWin95 or another tool.

Chapter 1

Introduction

As reported from the National Hurricane Center, Floyd developed from a tropical wave off the coast of Africa on September 2, 1999. Floyd became a tropical storm on September 8, 1999 about 850 miles east of the Lesser Antilles and continued to move westward, becoming a hurricane about 240 miles northeast of the northern Leeward Islands. The westward movement changed to north westward, temporarily halting its intensification trend. However, Floyd turned back to the west and strengthened into a major hurricane, intensifying to a Category 4 hurricane with 155 MPH winds. On September 13, Floyd ravaged portions of the central and northwest Bahamas heading for the U.S. Floyd continued to move along the Florida coastline, causing mass evacuations in Florida, Georgia, South Carolina, and North Carolina. Floyd eventually turned north westward and slowly weakened making landfall on September 16, 1999 near Cape Fear, North Carolina as a Category 2 hurricane. Hurricane Floyd moved over the eastern part of North Carolina and accelerated up the coast where it weakened to a tropical storm before moving into New England. Floyd lost its tropical storm characteristics by September 17, 1999.

Prior to Hurricane Floyd, comprehensive hurricane evacuation studies (HES) had been conducted for many of the impacted areas. Most of these studies and their associated work products are jointly funded by the Federal Emergency Management Agency (FEMA), the U.S. Army Corps of Engineers (USACOE) and the National Weather Service (NWS). Two of the study areas had products that were developed by regional planning councils in Florida.

With these studies in hand and with some draft restudy products on the table, Floyd provided an opportunity to answer several key questions regarding these major FEMA/Corps planning efforts:

Did local and state officials use the products produced in the studies?

Were study data regarding storm hazards, behavioral characteristics of the threatened population, shelter information, evacuation times, and decision-making accurate and reliable?

Which study products were most useful and which least useful - what improvements could be made to current methodologies and products?

To answer these questions, study teams consisting of representatives from FEMA, the Corps of Engineers, and Post, Buckley, Schuh & Jernigan, Inc. visited with local and state officials throughout the directly responding or impacted areas of coastal Florida, Georgia, South Carolina, and North Carolina. Post, Buckley, Schuh, & Jernigan, Inc. was retained to accompany the study team and document all relevant findings. Many local and state officials provided their observations. Local emergency management directors, law enforcement officers, and shelter personnel were involved in meetings held in each area that responded to Hurricane Floyd. Separate meetings were held to discuss study product usage with local media representatives. Appendix A lists those individuals who either attended meetings or provided input through telephone conversations.

Discussion with local emergency management officials focused on study products and their use relative to the evacuation decision process, evacuation clearance time, sheltering, and public information. Discussions with state officials centered on the role the state played in the evacuation process, including the use of study products in communicating with local officials. Media representatives were asked to focus on study related materials that they possessed and that were broadcast to the general public. They also addressed the types of materials and public information they could have used that had not been developed or delivered to them to date.

In addition to the meeting held with state and local officials, Hazards Management Group conducted and analyzed a residential behavioral sample survey for selected communities in Florida, Georgia, South Carolina, and North Carolina. Telephone interviews were conducted to ascertain actual evacuation response in Floyd and to predict evacuation response parameters for future comprehensive hurricane evacuation restudies. The behavioral analysis focused on the actual percent of the affected population that evacuated during Floyd, when the evacuees left their residence, what sort of evacuation refuge was used, where the refuge was located, and the number of vehicles used by evacuating households.

This report documents the findings of the study team and is organized by general category of hurricane evacuation study product. Those general categories that are addressed include:

Hazards/Vulnerability Data

Behavioral Characteristics of Evacuees

Shelter Issues

Transportation/Clearance Time Data

Evacuation Decision-Making

Public Information

Each of the following chapters describes typical study components and products produced in comprehensive hurricane evacuation studies. The chapter then summarizes actual data related to Floyd and, where relevant, compares it with study produced data for a relevant storm scenario. Recommendations are then given for future study efforts concerning that study topic.

Chapter 2

Hazards/Vulnerability Data

In FEMA/Corps comprehensive hurricane evacuation studies, the primary objective of the hazards analysis is to determine the probable worst-case storm surge effects for the various intensities of hurricanes that could strike an area. Specifically, a hazards analysis quantifies the expected hurricane-caused inundation that would require emergency evacuation of the population. Historically, the hazards analysis also has assumed that mobile homes outside the surge inundation area must be evacuated due to their vulnerability to winds. The National Weather Services' SLOSH (Sea, Lake, and Overland Surge from Hurricanes) numerical storm surge prediction model was used as the basis of the hazards analysis for studies that have been completed or studies that are ongoing in Florida, Georgia, South Carolina, and North Carolina.

The vulnerability analysis uses the hazards analysis to identify the population potentially at risk to coastal flooding caused by the hurricane storm surge. Storm tide atlases are produced showing the inland extent of surge inundation for various hurricane intensities.

Hazards and vulnerability issues related to Floyd that were discussed with local and state officials included the following:

What technical data/mapping were used to choose the areas to evacuate?

Did the technical data provide a good depiction of the hazards area?

As in previous post storm assessments, the National Hurricane Center was able to compare SLOSH model predictions with actual high water marks for Floyd's track along the U.S. coast. The results of the SLOSH comparison are similar to previous hurricane storm surge comparisons and generally show that the SLOSH model calculates the storm surge within plus or minus 20 percent of the observed values.

In addition to the SLOSH model comparison, the National Hurricane Center provided their preliminary forecast and warning critique for Hurricane Floyd. Appendix B includes the "Best

Track" positions for Hurricane Floyd, including positions, barometric pressure, wind speed, and storm classification by date. The appendix also includes a table reporting selected surface observations at various localities throughout the impacted areas and a tropical cyclone watch and warning summary for Floyd.

Excerpts from the NHC report regarding the SLOSH model performance are provided as follows:

Although Hurricane Floyd produced extensive fresh water flooding from the mid-Atlantic states northward into New England, it produced salt water storm surge flooding along the entire eastern Atlantic seaboard. Figure 2-1 shows the track of Floyd and the maximum observed storm surge at various locations along the Atlantic coast from Miami, Florida to Boston, Massachusetts. All of the values, except two, were obtained from tide gages by subtracting the predicted astronomical tide value from the observed value at the gage and taking the maximum difference. The two debris line observations located on the eastern shore of the Chesapeake Bay were included because no tide gage was located nearby and there were reports of flooding into low-lying buildings near the shoreline. The reader is cautioned that these two values may contain an astronomical tide component as well as breaking wave effects.

Floyd roughly paralleled the coastline and remained offshore from Miami, Florida to landfall at Cape Fear, North Carolina. The wind field on the left-hand side of the eye generated some onshore wind component which produced a range of storm surge values from 1.5 to 4.0 feet.

With landfall in North Carolina, the winds ahead of the eye drove water onshore on the Atlantic shoreline and westward in the Pamlico and Albemarle Sounds and up several of the rivers located on the west side of the sounds. The highest storm surge values ranged from 5.5 to 9.0 feet. The 9.0 foot storm surge maximum(the highest observed in Floyd) was obtained by an observer near Wilmington, North Carolina. The observer was located south of the city on the Atlantic shoreline. Figure 2-2 is a graph of time versus water elevation in feet at this location. The water elevation is referenced to NGVD or the National Geodetic Vertical Datum. NGVD is the location of mean sea level in 1929. The water elevation also contains the astronomical tide component. The maximum observed storm surge plus tide component was 10.3 feet. The astronomical tide component was predicted at plus 1.3 feet at this maximum and the difference gives 9.0 feet. The National Weather Service's storm surge model, called SLOSH, was run in a hindcast mode for this area with the added 1.3 foot high tide component included. Then a direct comparison was made between the observed storm tide and the SLOSH computed storm tide. This comparison is seen in Figure 2-2. The SLOSH simulates the timing and peak storm tide value but seems to under forecast the elevations before the maximum occurs and over forecast after the maximum occurs. This suggests a timing problem in the track of the hurricane, but the most important part, the

Figure 2-1

**OBSERVED MAXIMUM STORM SURGE HEIGHTS
FOR HURRICANE FLOYD**

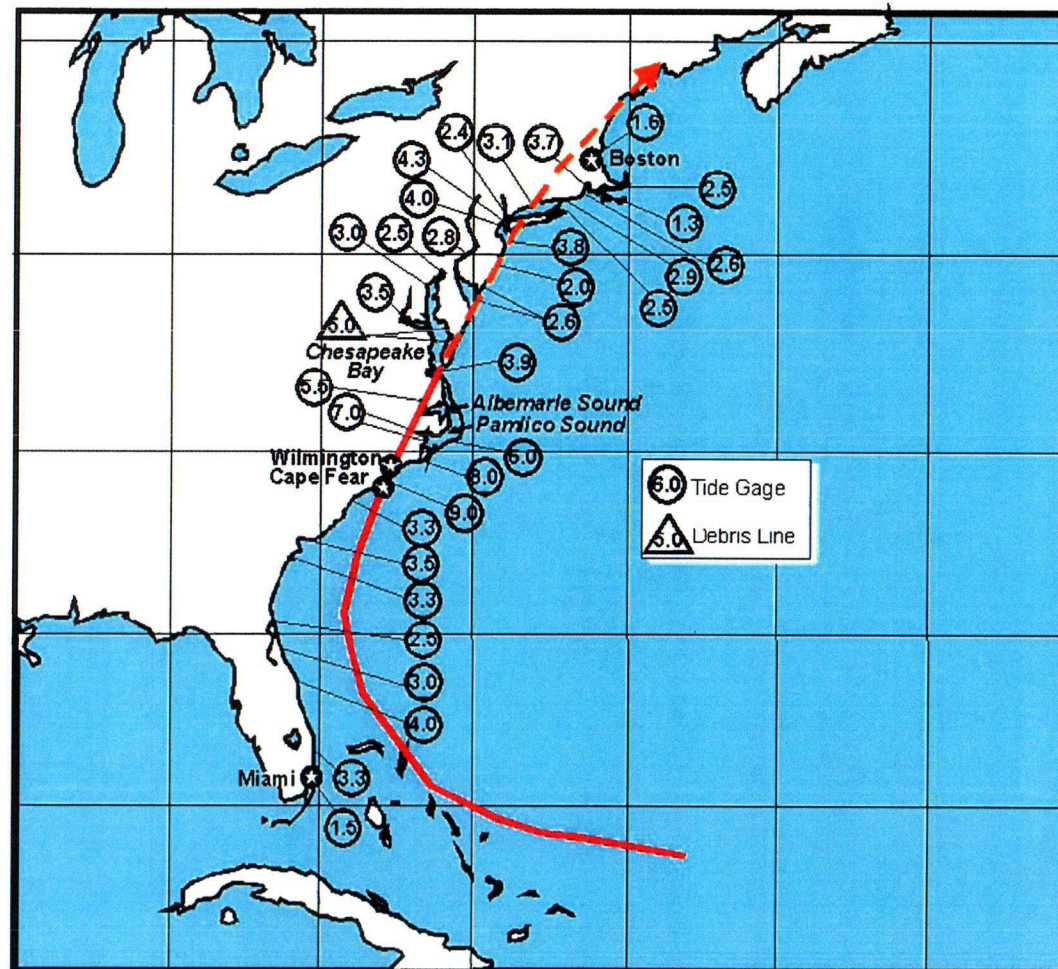
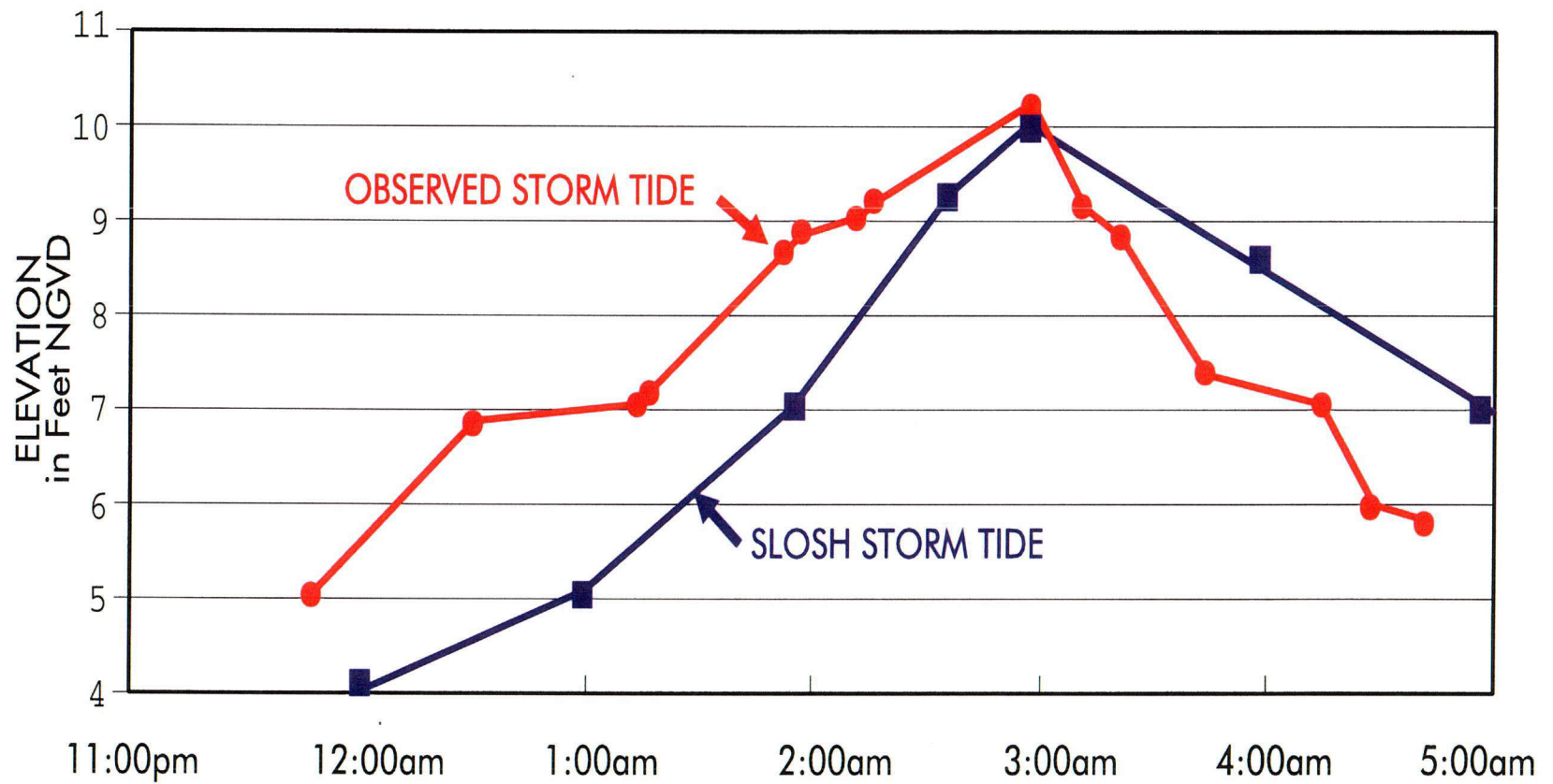


Figure 2-2

Hurricane Floyd Water Levels September 15 & 16, 1999



maximum surge, is calculated by the model. Typically, the SLOSH model calculated values are within plus or minus 20 percent of the observed.

The hurricane weakened to a tropical storm as it passed the mouth of Chesapeake Bay and continued north-northeastward into New England. The range of storm surge values ranged from 1.3 to 4.3 feet in this region. The two observed debris line elevations on the southeastern Chesapeake shoreline were caused by westerly and southwesterly winds as the center of Floyd passed abeam and to the north of these locations. Saltwater flooding from the bay occurred in some buildings along this reach of coastline. Actual measured still water elevations relative to NGVD from these structures were not available for comparison at the time of this report.

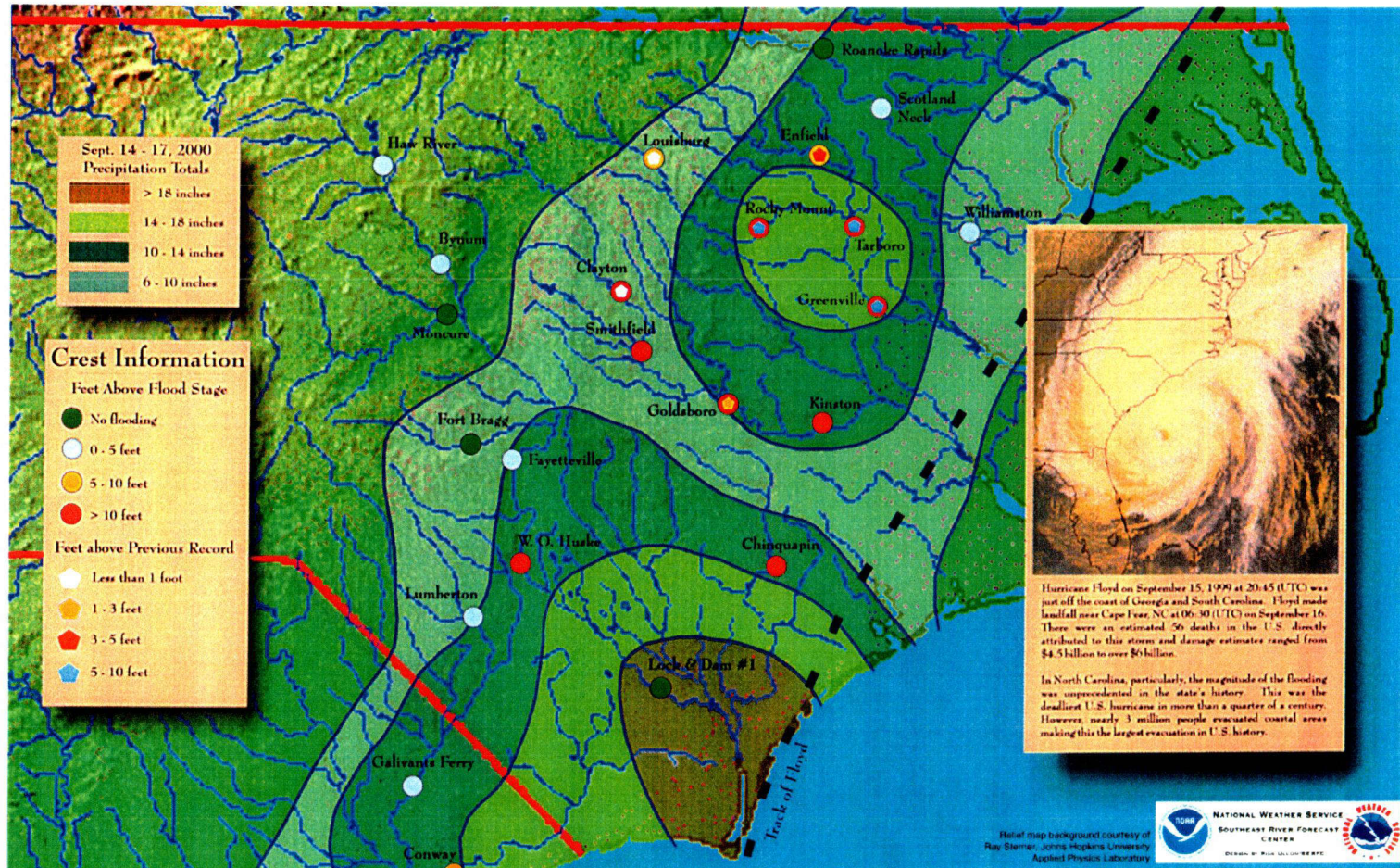
The inland rainfall associated with Floyd was particularly noteworthy and severe in eastern North Carolina. Many communities were devastated and recoveries will take years to be completed. A graphic prepared by the NWS showing rainfall levels and river flooding in North and South Carolina is provided in Figure 2-3.

Recommendations:

1. Build an inland flooding component into the HES process using the ongoing North Carolina Hurricane Evacuation Restudy as a starting place.
2. Continue to refine the development of storm tide mapping, automating line delineation while lowering study production costs.
3. Use the Internet as a tool for disseminating storm surge mapping information as Wilmington District has done in creating "ncstormsurge.com."

Figure 2-3

Hurricane Floyd Precipitation and Crest Information for North Carolina and South Carolina



Chapter 3
Behavioral Analysis – Public Response in Floyd
(Prepared by Hazards Management Group)

The narrative below is provided by Hazards Management Group (HMG) for the post Floyd evacuation assessment and focuses on describing the evacuation behavior of permanent residents in Florida, Georgia, South Carolina, and North Carolina.

Method

During the months following hurricane Floyd, nearly 7,000 members of the public were interviewed to document and explain their response in Floyd and to help anticipate their behavior in future evacuations like Floyd. The sample was divided into 11 clusters of counties from Dade County, Florida through North Carolina's Outer Banks, designed to conform to hurricane planning regions used by the respective states:

1. Eastern North Carolina – the Outer Banks and counties along Albemarle and Pamlico Sounds
2. Southeastern North Carolina – from the South Carolina border to the Outer Banks, including Wilimington
3. Northern South Carolina – including the Myrtle Beach “Grand Strand” area
4. Central South Carolina – including Charleston and vicinity
5. Southern South Carolina – including the Beaufort area
6. Northern Georgia – including Savannah
7. Southern Georgia – including Brunswick and Camden County
8. Northeast Florida – including Jacksonville and St. Augustine
9. East-Central Florida – including Daytona Beach and Melbourne
10. Treasure Coast Florida – including Palm Beach and Fort Pierce
11. Southeast Florida – Dade and Broward Counties

Each of the eleven areas were stratified into four risk areas. The following is a listing of the four risk areas and the number of interviews conducted in each risk area:

1. Areas which would flood due to storm surge in category 1 hurricanes, in which 200 telephone interviews were conducted
2. Areas which would flood due to storm surge in stronger hurricanes, in which 200 telephone interviews were conducted
3. Areas of coastal counties which would not flood from storm surge in any hurricane, in which 100 telephone interviews were conducted
4. Non-coastal counties bordering the coastal counties, in which 100 telephone interviews were conducted.

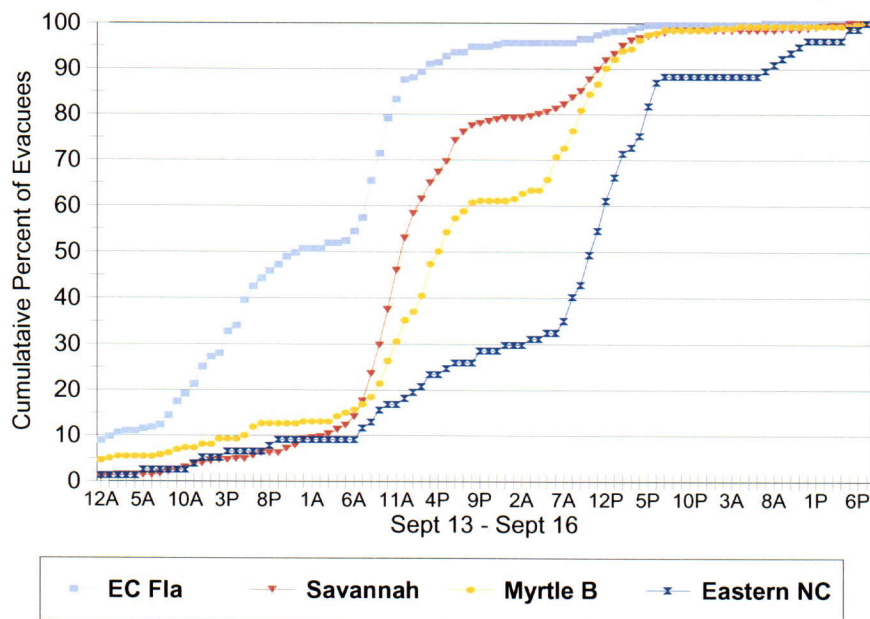
In southeast Florida, 200 interviews were conducted in the non-surge portion of the coastal counties rather than including non-coastal counties. In southern Georgia, virtually the entire coastal counties are subject to storm surge inundation in strong hurricanes, so there was no identification of non-surge portions of those counties. In eastern North Carolina the Outer Banks were treated in the design and analysis like the category 1 risk area of other locations, and areas along the sounds subject to surge inundation were treated as "other surge" areas for comparison with the other locations.

A generic version of the questionnaire used in the survey is included as an appendix to this report. Separate detailed reports were prepared for each of the 11 areas, and can be found in the documentation of the Southeast United States Hurricane Evacuation Study entitled *Technical Memorandum 1 Behavioral Analysis*. For conciseness, sample sizes are not reported in the figures cited in this summary document. Readers should keep in mind that statistics reported here are based on samples derived from larger populations. For more information about sample sizes employed for each question in each location and each risk zone, please refer to the individual area reports.

Evacuation Timing

Figure 1 is a sample of the “cumulative response curves” derived for each of the 11 areas. The vertical axis indicates the percentage of total evacuees from a location who had departed their homes by various times. The four curves show the progression of the evacuation commencing earlier to the south and gradually moving northward as the forecast track of the storm and warning areas moved northward. The curves are typical of “two-day” response curves – i.e., evacuations which take place over a period longer than 24 hours. The evacuation begins early on the first day, levels off at evening of the first day, then resumes the following day. Little evacuation began prior to evacuation notices being issued by officials.

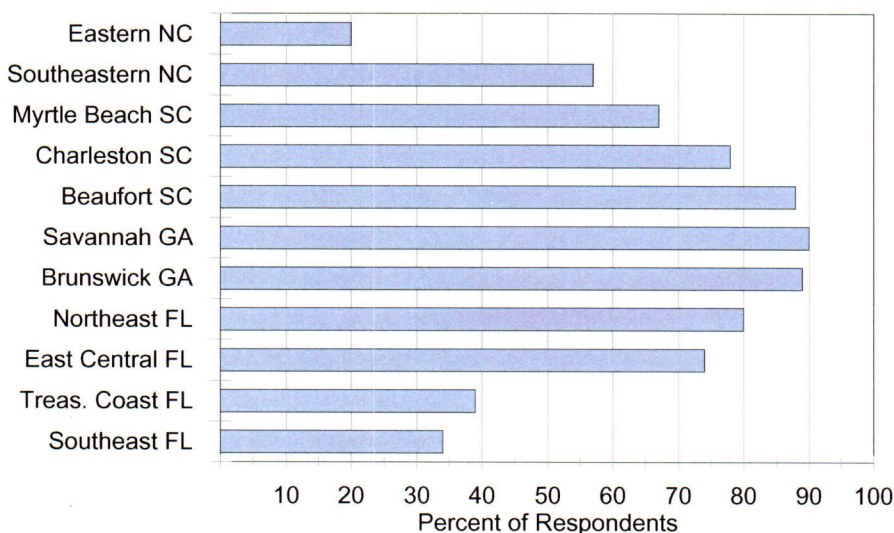
Figure 1
Evacuation Timing in Floyd



Evacuation Participation Rates

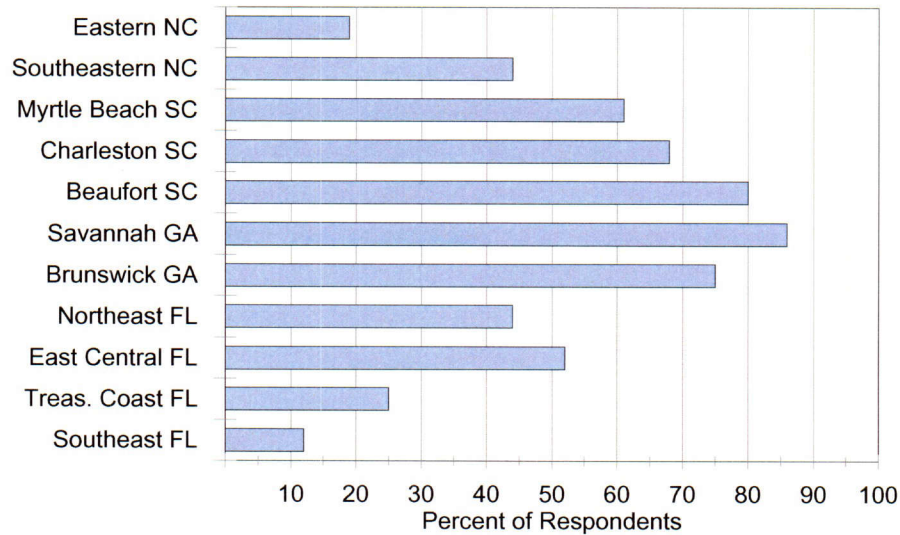
There was considerable variation in evacuation rates among the 11 survey areas (Figure's 2-5). Evacuation (i.e., leaving one's home to go someplace safer) was highest in Georgia and southern South Carolina. In the category 1 zone up to 90% left from the Savannah area, and numbers were almost as high around Brunswick and Beaufort. Rates dropped off gradually both north and south, with major dropoffs for the Treasure Coast and southeast Florida and eastern North Carolina areas.

Figure 2
Participation Rates in Floyd
Cat 1 Surge Zone



Evacuation was also high in Georgia and in the Beaufort, SC area for people living in areas subject to surge inundation in storms stronger than category 1, with 75% to 85% leaving from those areas. Again, the dropoff was gradual in both directions, with more significant decreases at the ends of the study area. In Florida only category 1 surge areas were ordered to evacuate. In Georgia and southern South Carolina entire coastal counties were told to evacuate.

Figure 3
Participation Rates in Floyd
Surge Zones Outside Cat 1



In the Charleston, Beaufort, and Savannah areas evacuation from non-surge zones was unusually high. In all three areas all or most of the counties were told to evacuate. Even away from those locations between 20% and 40% of the non-surge residents left in most survey areas. These “shadow” evacuees contributed to the number of people on evacuation routes.

Evacuation in adjacent non-coastal counties was surprisingly high, averaging approximately 25%. In the Charleston vicinity almost half the residents in adjacent non-coastal counties evacuated their homes.

Figure 4
Participation Rates in Floyd
 Coastal Non-Surge Zone

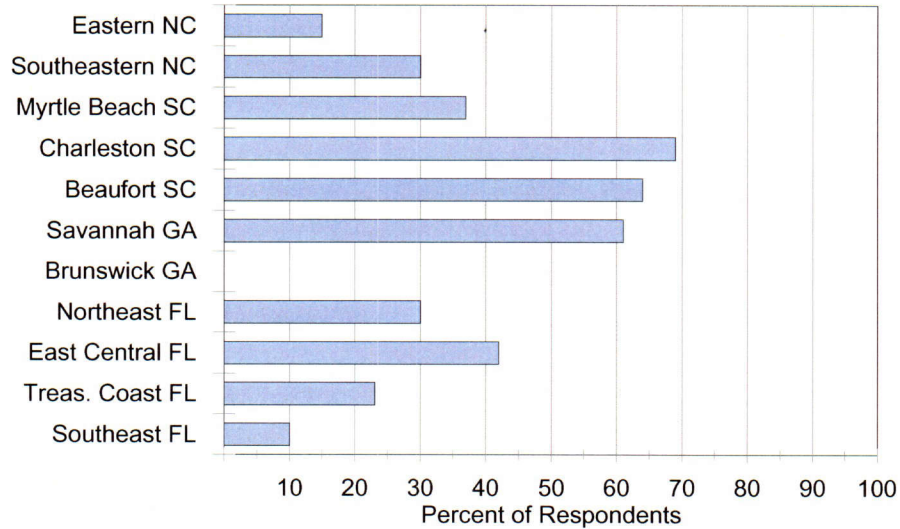
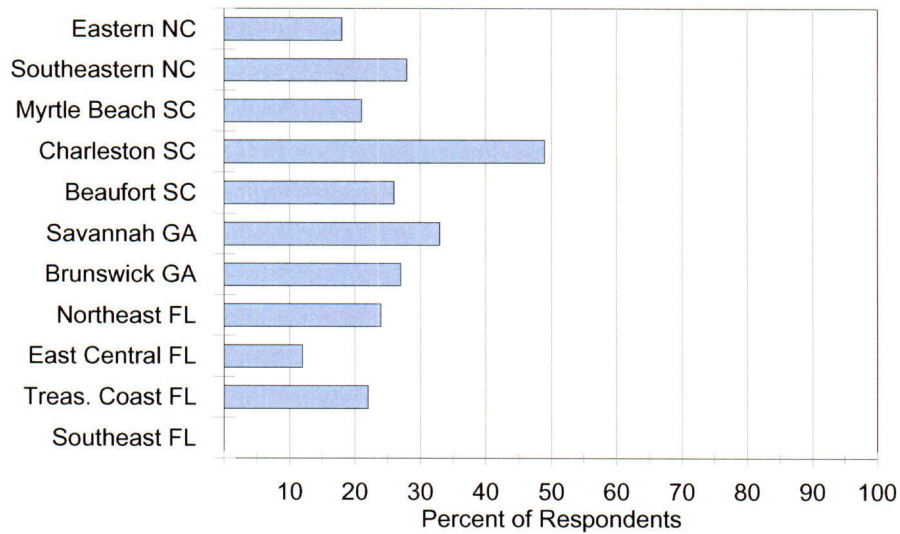
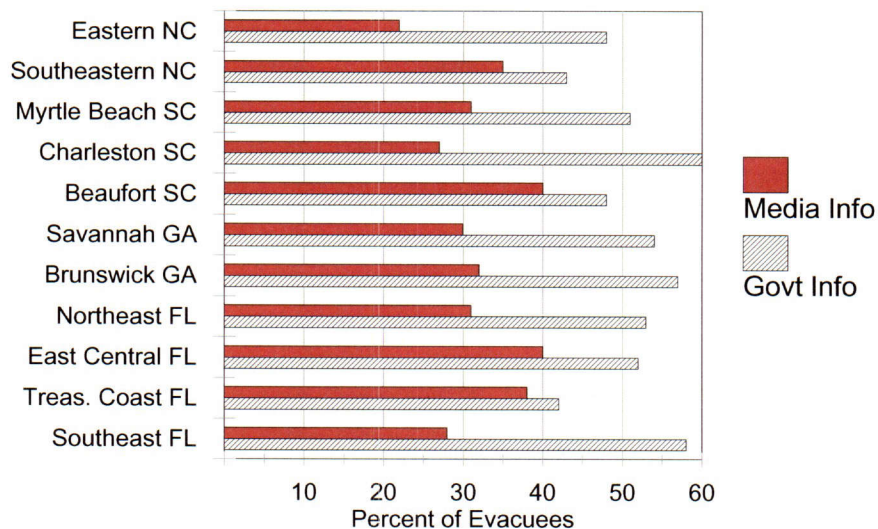


Figure 5
Participation Rates in Floyd
 Adjacent Non-coastal Counties



Respondents who evacuated were asked why they left, and most said they left because of a combination of reasons such as evacuation notices from public officials, storm severity, and recommendations from friends, family, and the media. To sort out the effects of official information heard via the media and other kinds of information heard through the media, evacuees were asked which was the main influence on their decision to evacuate. For most people, information coming from public officials (or which they perceived to be coming from officials) had the greater effect (Figure 6).

Figure 6
Main Reason for Evacuating
Avg. All Zones



Except in the two southernmost Florida locations, most people living in category 1 surge areas said they heard officials call for their evacuation (Figure 7). The highest percentage was only 80%, however, in Charleston. In surge areas beyond the category 1 risk area, only in Georgia and South Carolina did most people hear evacuation notices from officials (Figure 8).

Figure 7
Heard Officials Say Evacuate
 Cat 1 Surge Zone

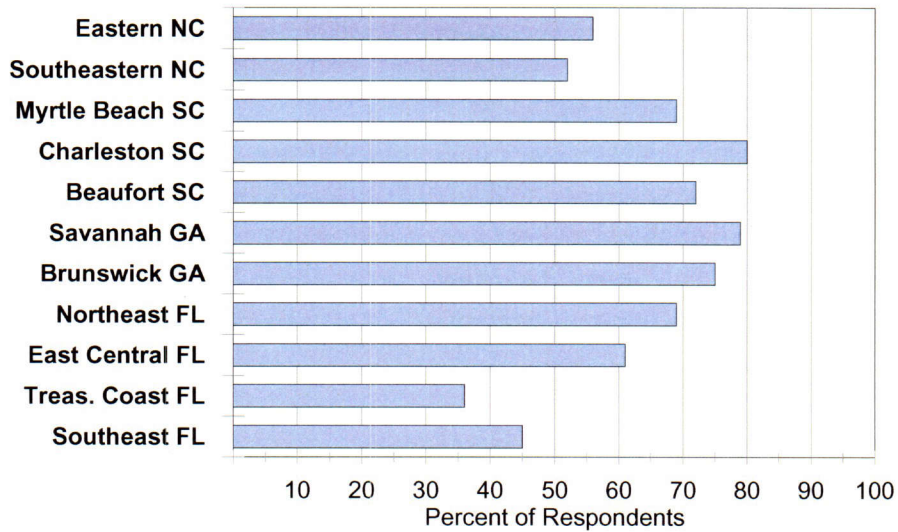
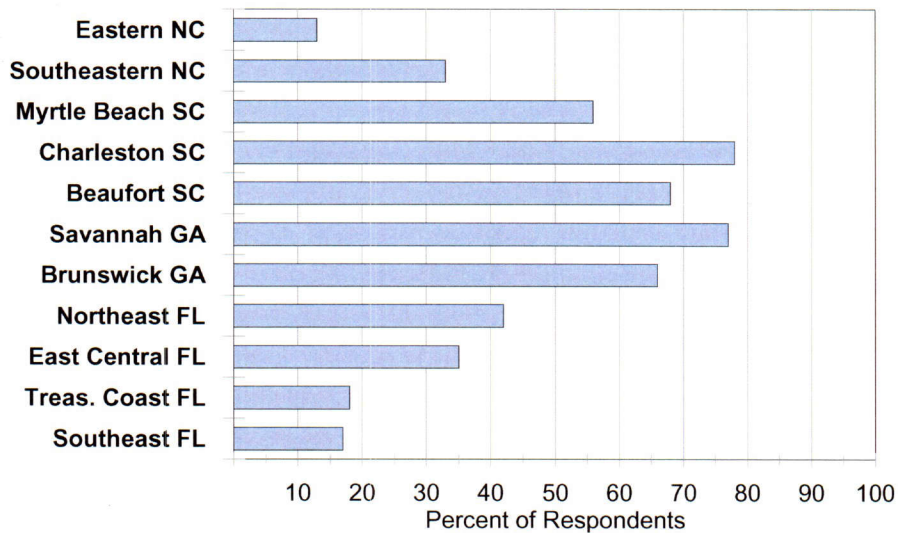


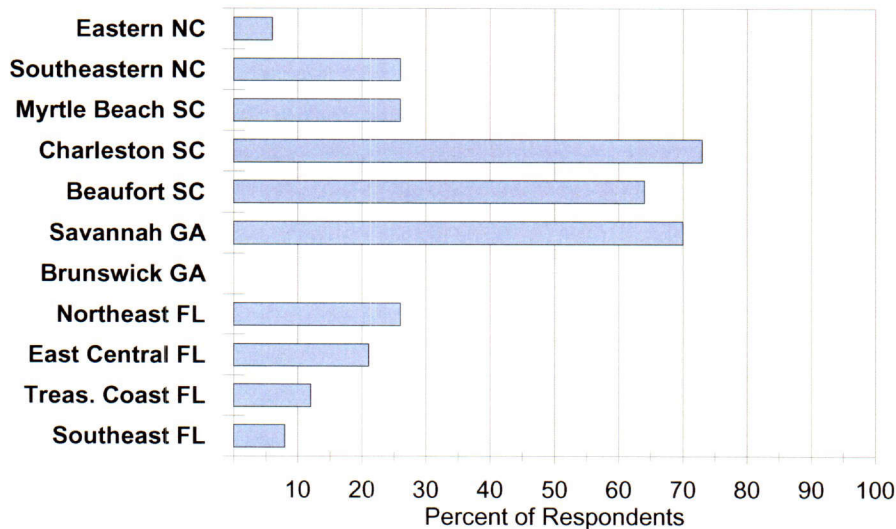
Figure 8
Heard Officials Say Evacuate
 Surge Areas Outside Cat 1



Some residents living in non-surge areas also believed they heard officials say that they should evacuate (Figure's 9-10). In Georgia and parts of South Carolina more than 60% of the non-surge residents of coastal counties said they heard official evacuation notices which applied to them, and that was probably correct for most. In other states, and in non-coastal counties, that was probably not correct, except for people living in mobile homes.

Figure 9

Heard Officials Say Evacuate
Coastal County Non-surge Areas



Hearing, or believing one heard, evacuation notices from public officials had a significant impact on whether residents evacuated (Figure 11). Within each of the four risk areas, people who said they heard mandatory evacuation orders from officials were most likely to evacuate, followed by those who said they heard officials recommend that they should leave, followed by people who said they didn't hear from officials that they should leave. It is extremely important for officials to reach those for whom evacuation notices are intended and to avoid confusing those for whom they are not intended.

Figure 10
Heard Officials Say Evacuate
 Adjacent Non-coastal Counties

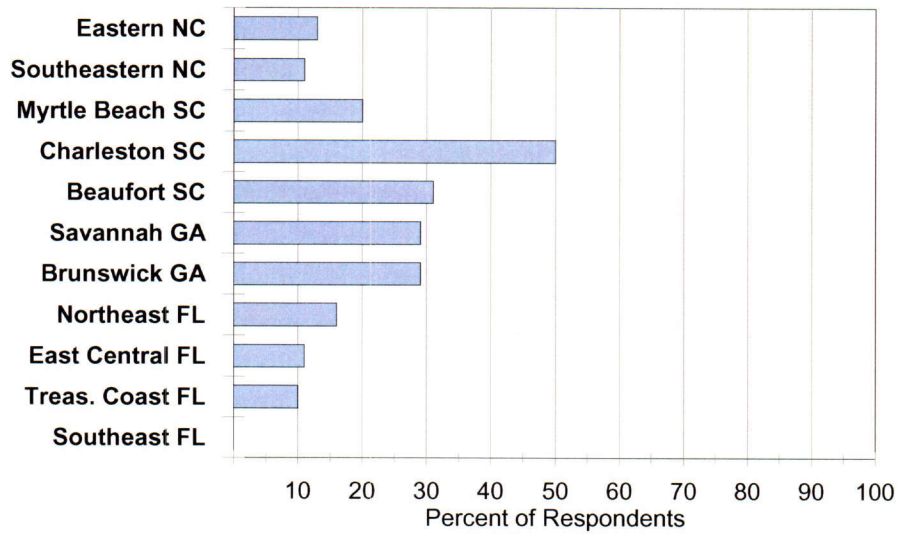
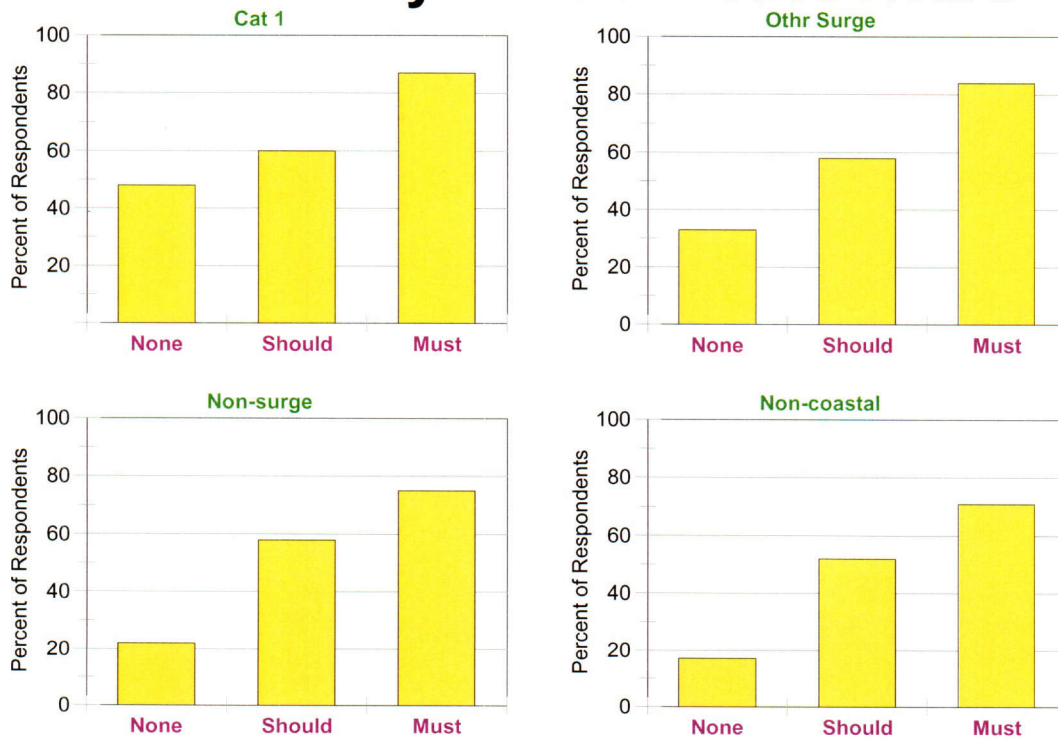


Figure 11
Evacuation by Official Notice Heard



One reason there was substantial evacuation from areas not targeted by officials is that many residents of non-surge areas perceive themselves to be vulnerable in major hurricanes (Figure's 12-13). When asked whether their homes would be safe in a 125 MPH hurricane, 20% to 40% of the people living in coastal county non-surge areas believe their homes would be unsafe from storm surge and waves, and 25% to 60% believe their homes would be unsafe, considering both wind and water. Even in adjacent non-coastal counties 15% to 35% believe their homes would experience dangerous flooding from storm surge or waves, and 40% to nearly 60% believe their homes would be unsafe, considering both wind and water. Although some of the areas might experience inland flooding from heavy rainfall, and some people live in mobile homes or substandard construction, most are probably overestimating their vulnerability.

The importance of the perception is depicted in Figure 14. People who believe their homes are unsafe are much more likely than others in their same risk area to evacuate. In most locations people who believe their homes are unsafe are about twice as likely as others to leave. This is a good thing when applied to people who really need to evacuate, but it can contribute to overcrowding on evacuation routes and in shelters when applied to people who could stay home and be safe.

There are various ways to reach the public with evacuation and vulnerability information during a hurricane threat, but local television and The Weather Channel are the most-relied upon sources of information in most locations (Figure 15). Eventually the Internet and online computer services will gain increased importance, but currently less than 10% of coastal residents say they rely heavily on those sources for hurricane information during a threat.

Figure 12
Perceived Unsafe in 125 MPH Hurricane
 Coastal County Non-surge Areas

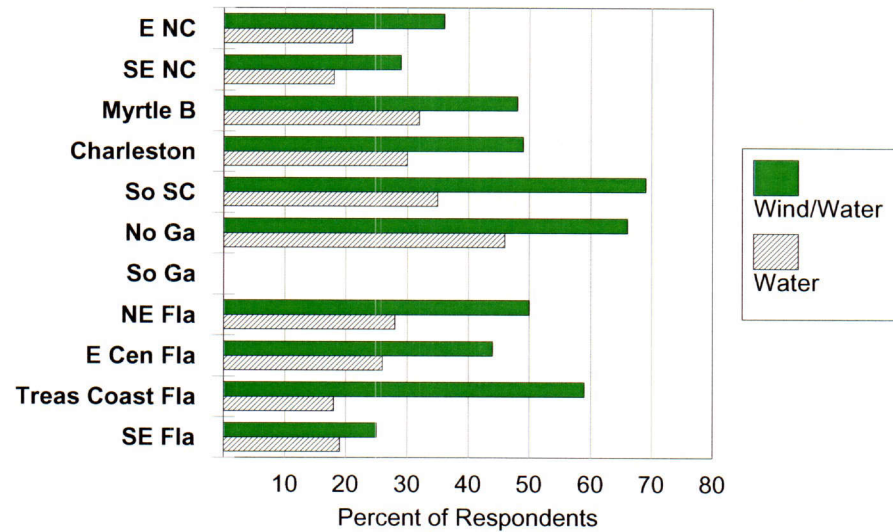


Figure 13
Perceived Unsafe in 125 MPH Hurricane
 Adjacent Non-coastal Counties

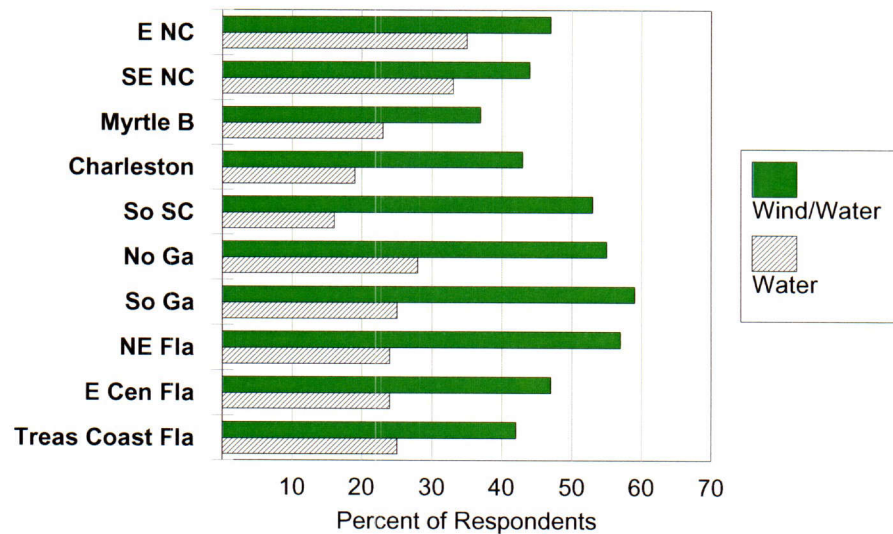


Figure 14
Evacuation by Perceived Safety
in 125 MPH Hurricane

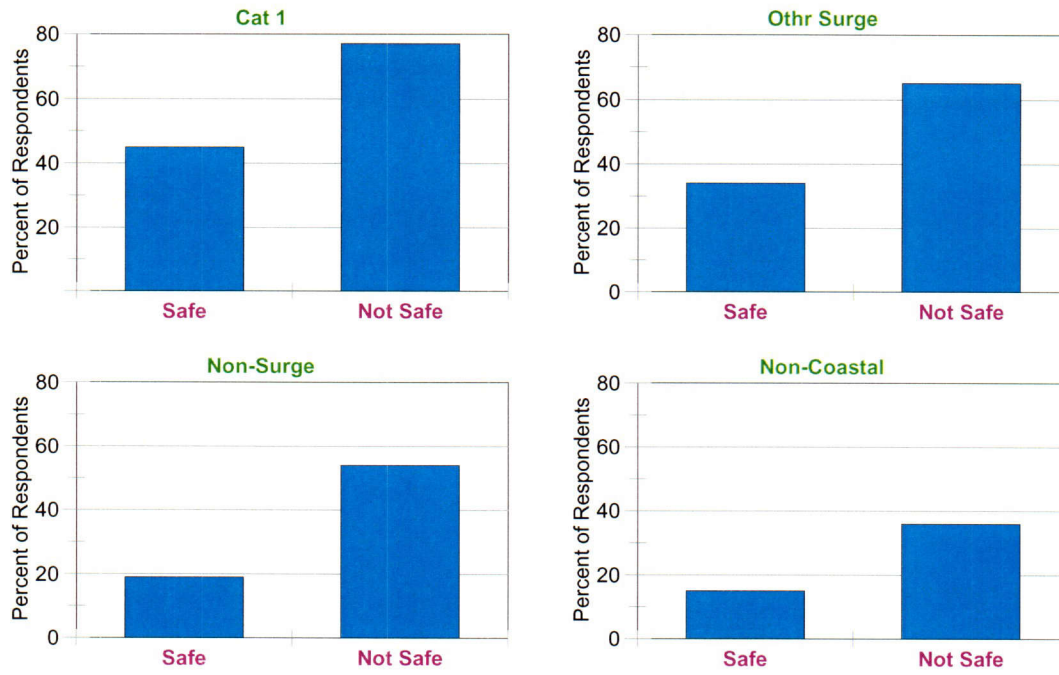
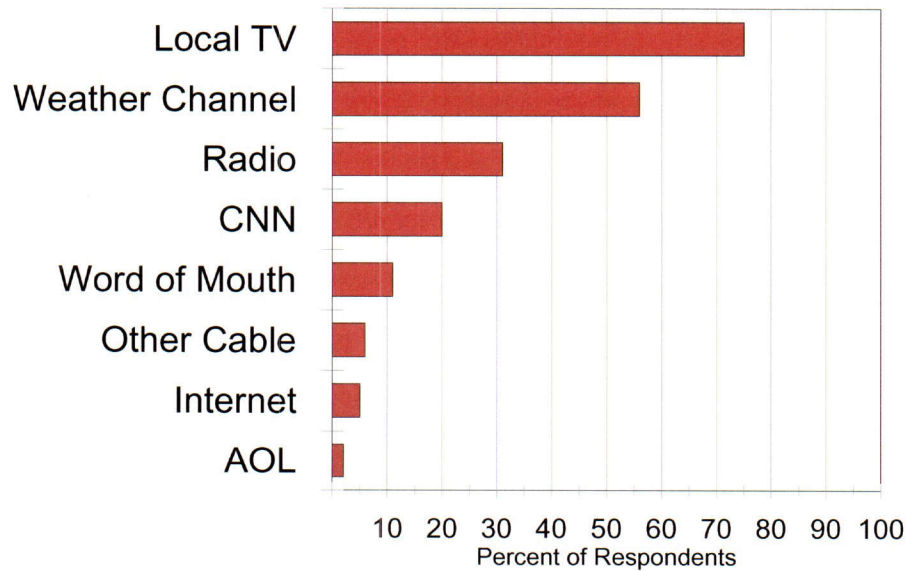


Figure 15
Relied on Sources a Great Deal



Evacuation Destinations

As indicated earlier, evacuation refers to leaving one's home to go someplace else. The new place can be across town or in a different state. Evacuation congestion is made worse when large numbers of evacuees leave the local area rather than simply going to safe locations within their own community.

In Floyd, an unusual percentage of evacuees went to destinations outside their own county (Figure's 16-19). Among evacuees from category 1 and larger surge zones, as many as 98% left their own county, and in eight of the eleven study locations more than 70% did so. These percentages are unusually high, but even in non-surge areas more than half the evacuees went out-of-county in eight of the ten non-surge locations (there was no sample of non-surge residents in the south Georgia area). In adjacent non-coastal counties more than half the evacuees went out of county from half the survey sites.

Evacuees who went to locations outside their own county were asked why they did so. In some places the answer was obvious. Georgia and some South Carolina locations evacuated entire coastal counties, so there were no places to go within those counties and still comply with evacuation notices. Moreover, in those locations residents appear to appreciate the vulnerability of their counties. In many locations, public shelters are not operated in coastal counties or even in the next tier of counties inland.

Respondents gave three predominant explanations for going out of county: 1) that was the location of friends or relatives with whom they could stay, 2) the storm was strong enough so they wanted to get far away from it, and 3) they had to go as far as they did to find vacant lodging.

Respondents were asked whether their decision to go out of county was mainly influenced by information they were hearing from public officials via the media, other information from the media, or information from friends and relatives. Influences varied among locations, but in

most places information from public officials had a greater influence than other messages heard through the media or from friends and relatives.

Figure 16
Evacuees Going Out of County
Cat 1 Surge Zone

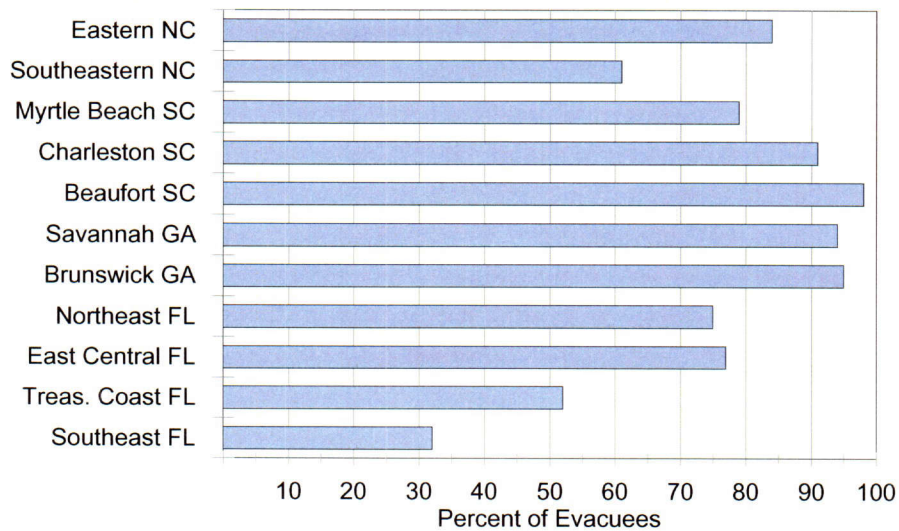


Figure 17
Evacuees Going Out of County
 Surge Zones Outside Cat 1

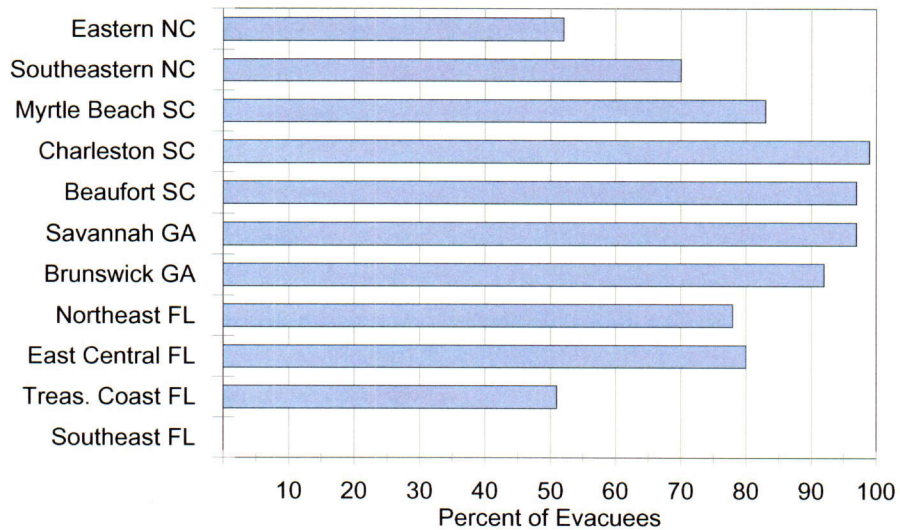


Figure 18
Evacuees Going Out of County
 Coastal Non-surge Zone

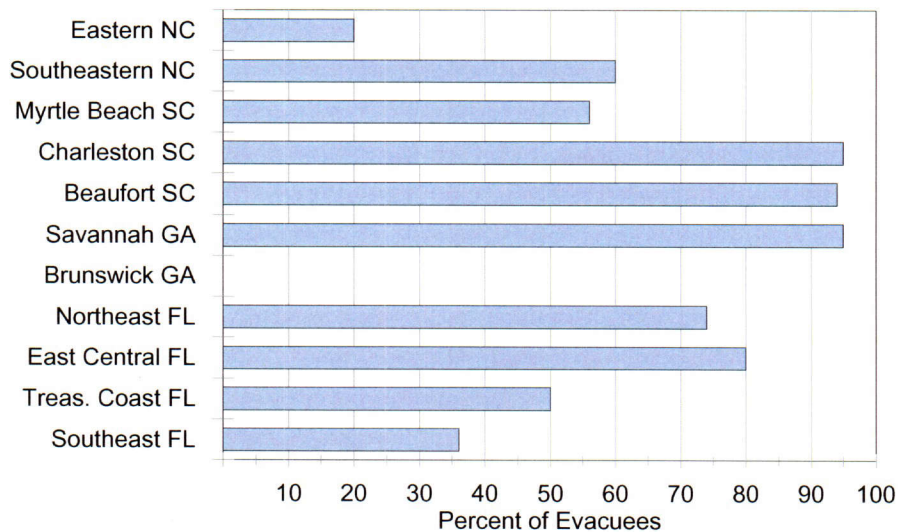
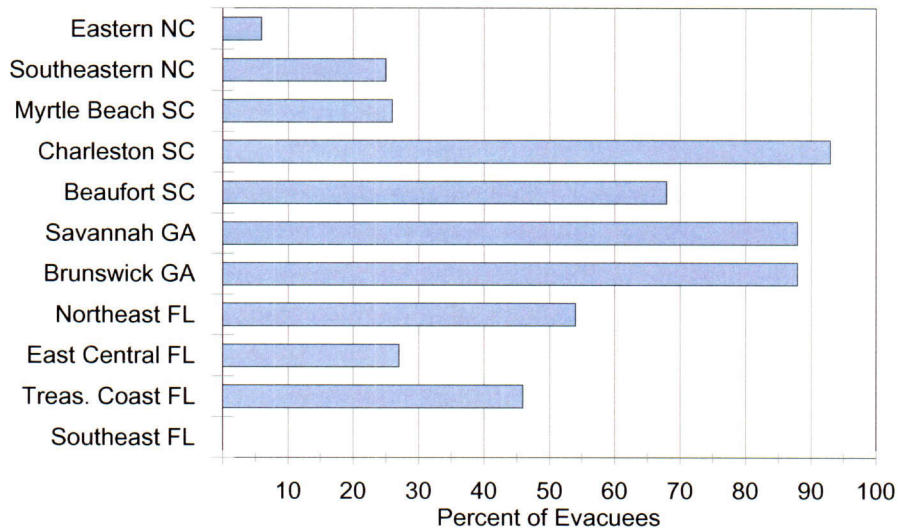


Figure 19
Evacuees Going Out of County
 Adjacent Non-coastal Counties



Between 85% and 90% of the evacuees said they reached their original destinations. Of those who changed plans roughly equal numbers went farther from home and closer to home than planned. Those going farther mainly did so looking for vacant lodging. Those who went less far did so mainly because of fatigue.

Few evacuees from other states went to Florida, which is understandable, given the track of the storm (Figure 20). Georgia, however, received visitors from both Florida and South Carolina (Figure 21). Thirty percent of the Northeast Florida evacuees went to destinations in Georgia, and 40% of those leaving Beaufort, SC went into Georgia. Few people from out of state went to South Carolina, and most evacuees from South Carolina went out of state (Figure 22). North Carolina received 14% of the Beaufort evacuees, 25% of those leaving Charleston, and 33% of those from Myrtle Beach (Figure 23).

Figure 20
Out of County Evacuees to Florida
 Avg. All Zones

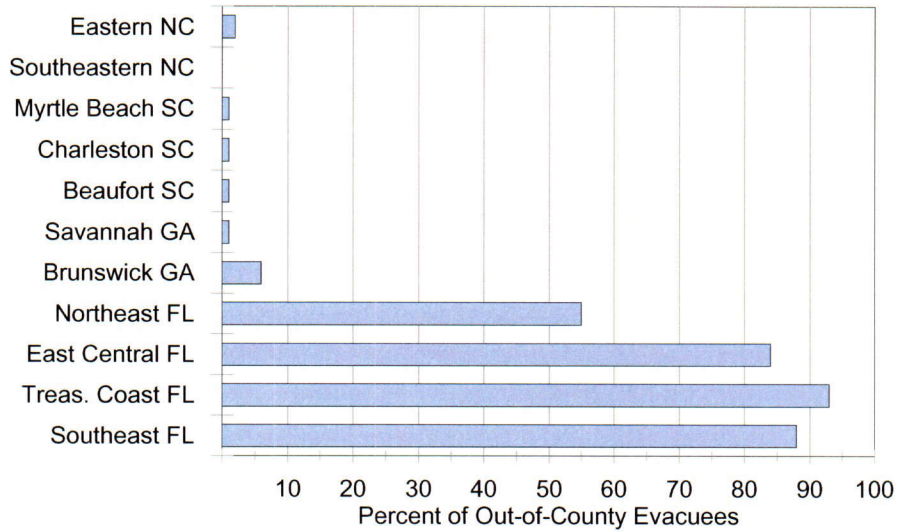


Figure 21
Out of County Evacuees to Georgia
 Avg. All Zones

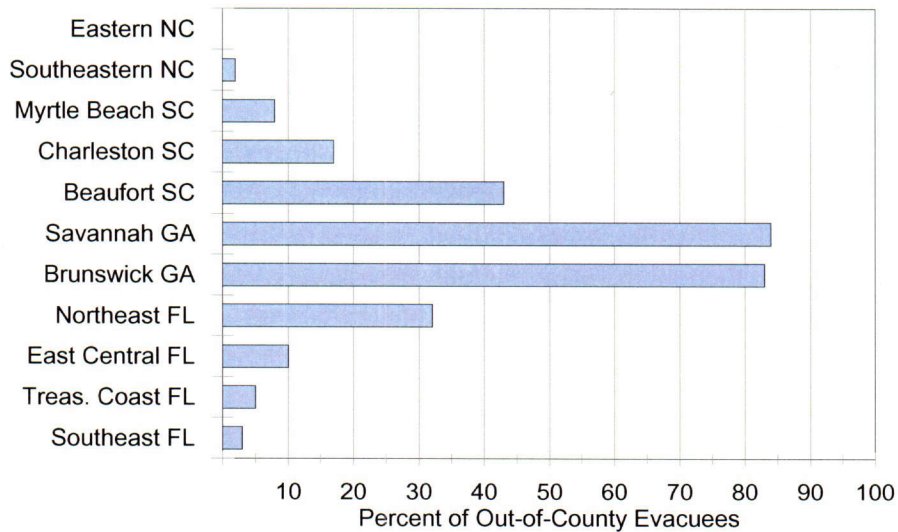


Figure 22
Out of County Evacuees to So. Carolina
 Avg. All Zones

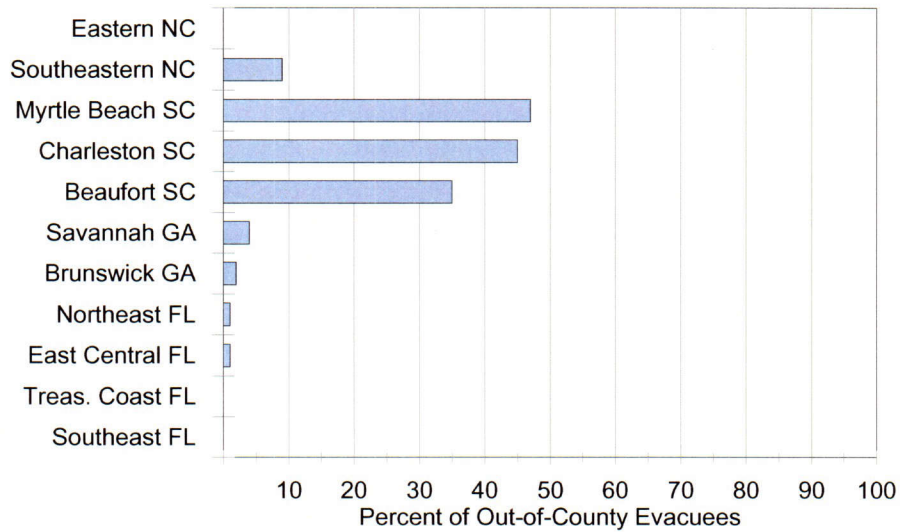
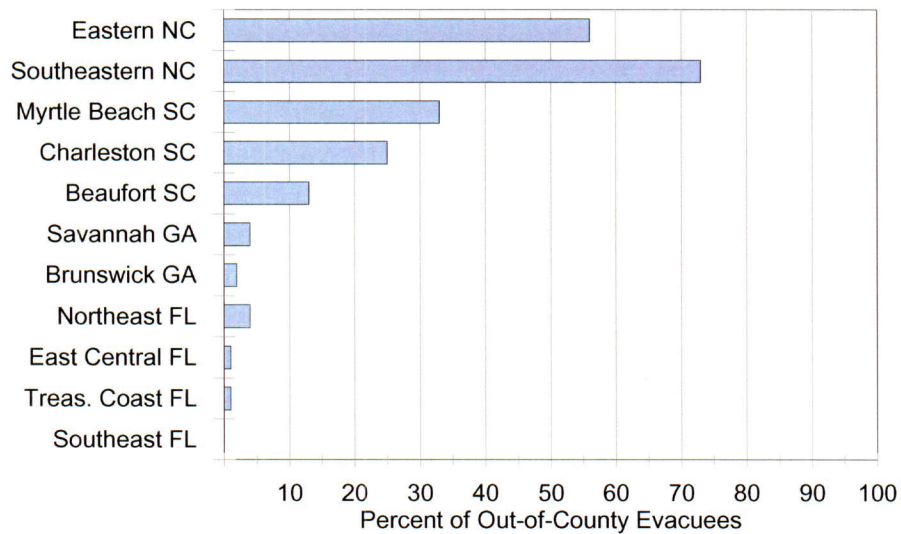


Figure 23
Out of County Evacuees to No. Carolina
 Avg. All Zones



The majority of evacuees went to the homes of friends and relatives, which is common in most evacuations (Figure 24). Between 20% and 30% in most locations went to hotels and motels (Figure 25), and fewer than 10% (closer to 5% in most locations) went to public shelters (Figure 26). The remainder went to a variety of places such as their place of work, second homes, and churches.

Approximately 40% of the evacuees said they heard announcements concerning the availability of shelters or refuges after they left home, but fewer than 10% of those who heard took advantage of the offers.

Figure 24
Evacuees Going to Friends/Relatives
Avg. All Zones

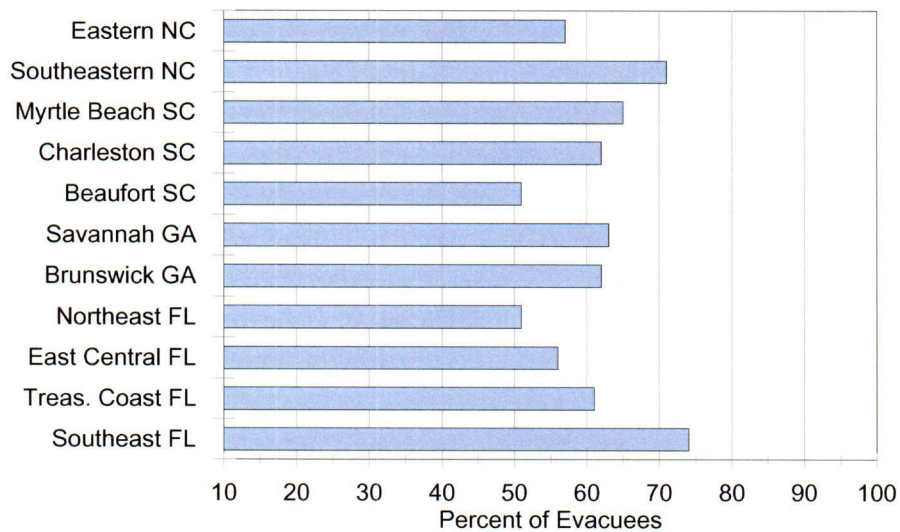


Fig 25
Evacuees Going to Hotels/Motels
 Avg. All Zones

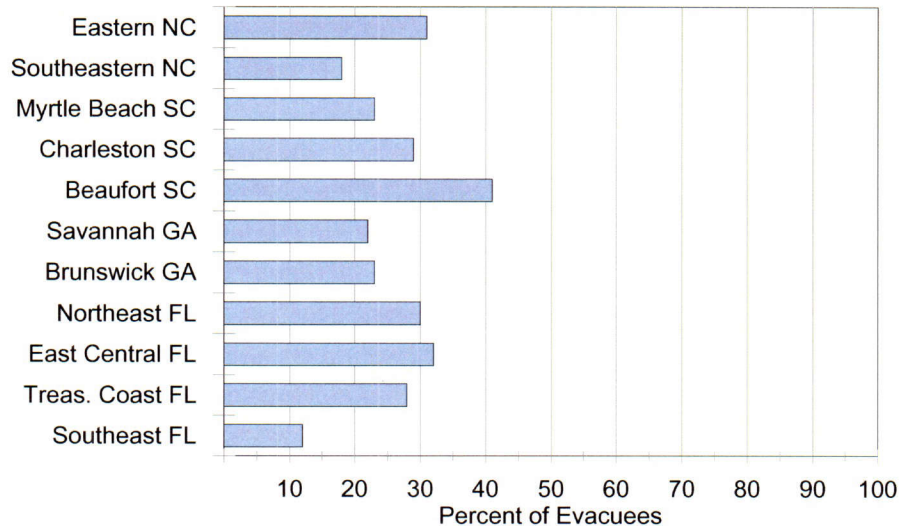
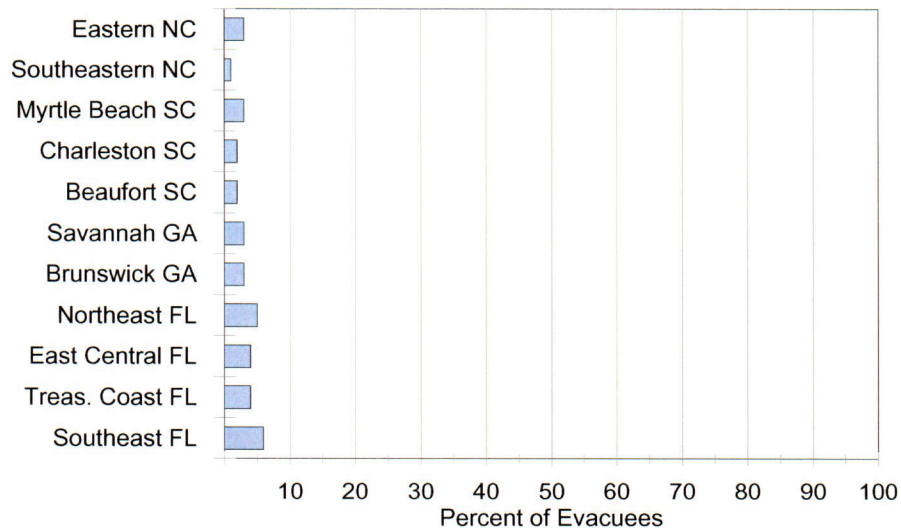


Figure 26
Evacuees Going to Public Shelters
 Avg. All Zones



Transportation

Of all the vehicles available to evacuating households, between 65% and 75% were used in Floyd (Figure 27). The statistic is typical of most evacuations.

Evacuees in Charleston had the longest average travel times -- almost nine hours (Figure 28). Beaufort and the two Georgia sites also had average travel times exceeding six hours. Respondents were also asked how long they had expected the evacuation to take, and not surprisingly, expectations were shorter than reality (Figure 29). In Charleston more than half of the evacuees said the evacuation took more than five hours longer than they expected, and in Beaufort and the Georgia locations almost half gave that response.

When asked the reasons for traffic delays, most respondents blamed the large volume of traffic and too many people leaving at the same time. In most locations fewer than 30% attributed the delays to poor management. The exception was Charleston, where over 40% gave that explanation. Some people mentioned the need to reverse lane evacuation routes.

Evacuees were asked whether they would be willing to delay their departure in an evacuation to let people in areas of greater risk leave first, in order to avoid congestion. Between 80% and 90% said they would (Figure 30). Whether quite so many actually would cooperate in that manner, the responses do demonstrate a significant receptivity to the argument if officials are able to make it with conviction.

Figure 27
Percent of Available Vehicles Used
 Avg. All Zones

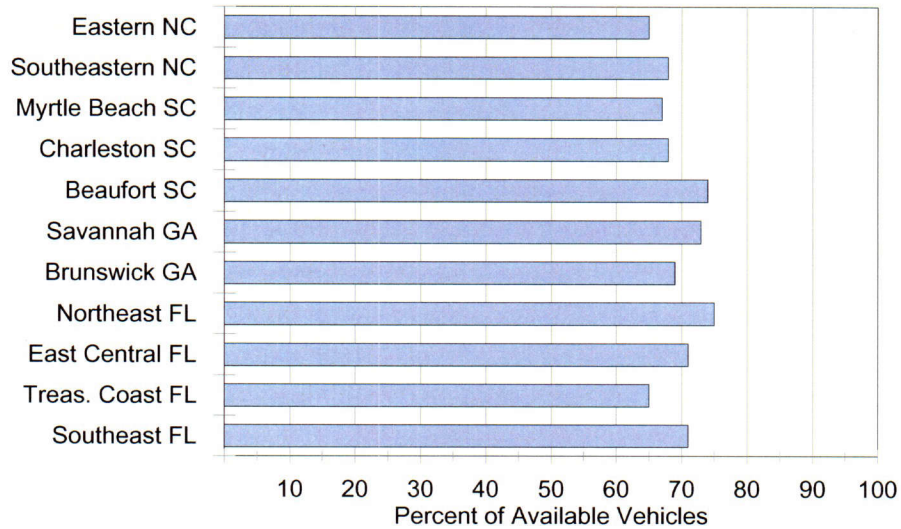


Fig 28
Mean Hrs to Reach Destination
 Avg. All Zones

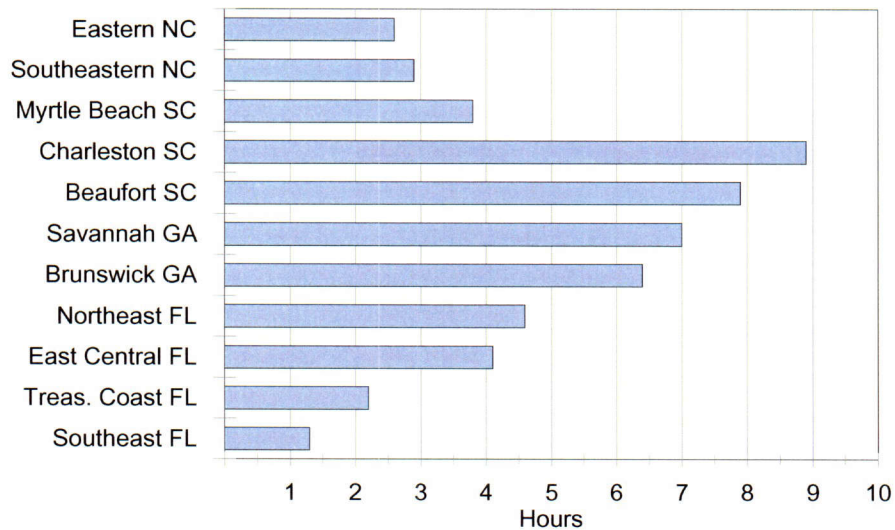


Figure 29
Taking > 5 Hrs More than Expected
 Avg. All Zones

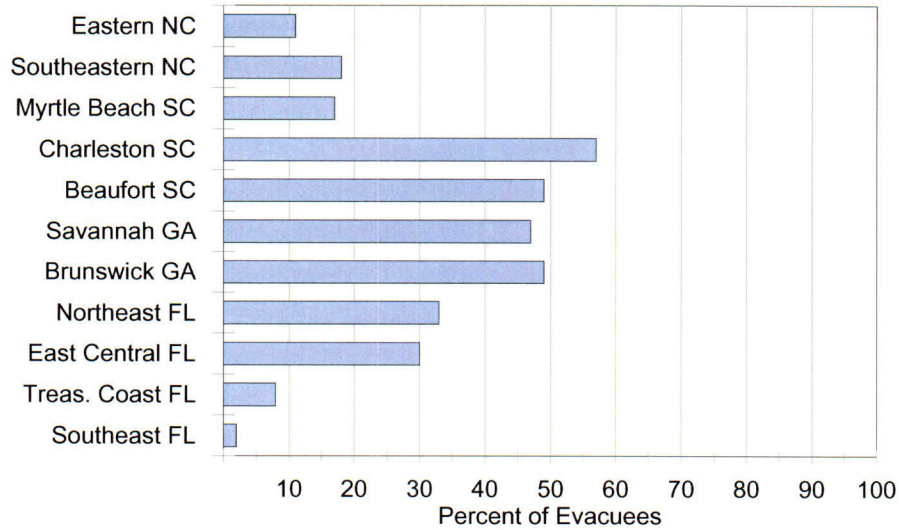
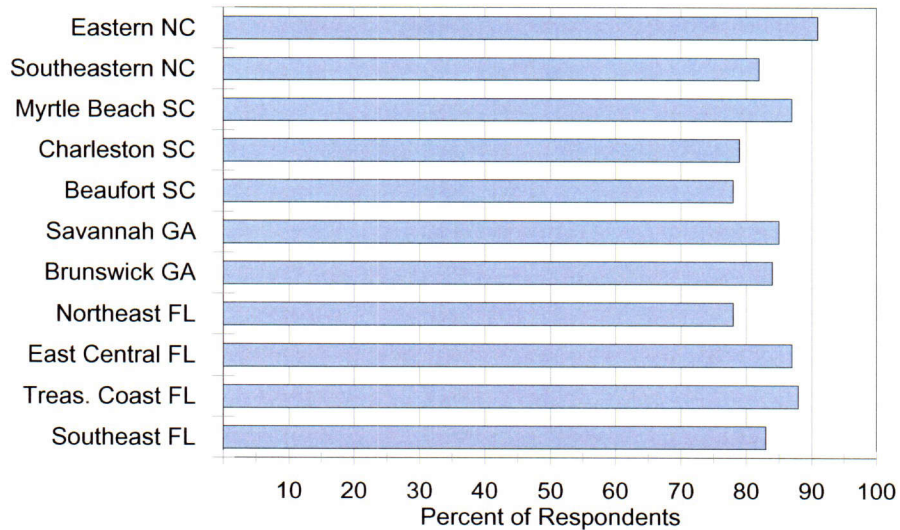


Figure 30
Would Delay Leaving If Urged
 Avg. All Zones



Between 35% and 60% of the evacuees said they used interstate highways for a substantial portion of their evacuation (Figure 31). Those respondents were asked whether they would use interstates again in the future or use secondary roads. In the area from Jacksonville, FL through Charleston, SC (where evacuation times were longest), most said they would use secondary roads, a combination of secondary and interstate, or that it would depend on circumstances. North and south of those locations (where travel times were shortest) a majority said they would use interstates in the future.

Between 70% and 90% of the respondents said they were familiar with the road systems in the areas through which they were evacuating (Figure 32). This implies that evacuees would be able to take advantage of information about alternative routes if they received the information. In Floyd between 20% and 55% of the evacuees said they heard announcements about evacuation route problems before leaving home (Figure 33). Of those hearing the announcements, approximately 30% changed their plans concerning routes to use in the evacuation. In most survey locations a majority of evacuees said they heard announcements once they left home about evacuation route problems (Figure 34). About 25% said they changed their route choices while underway as a result.

Evacuees appear to be receptive to route announcements, as evidenced by their behavior in Floyd and also in response to a hypothetical posed in the survey. Respondents were asked whether they would be willing to use a route other than the one they had planned to use if urged to do so by officials in order to avoid congestion, even if the alternative route took them out of their way. More than 70% said they would (Figure 35). The main point is not whether exactly that many would actually comply with such a recommendation but that so many are at least inclined to consider it favorably.

Figure 31
Use of Interstates in Evacuation

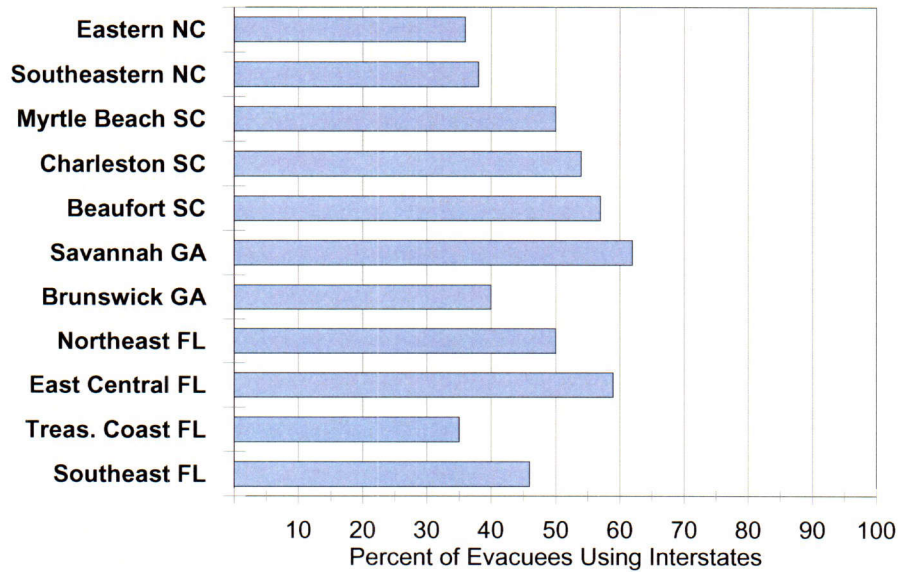


Figure 32
Familiar with Roads

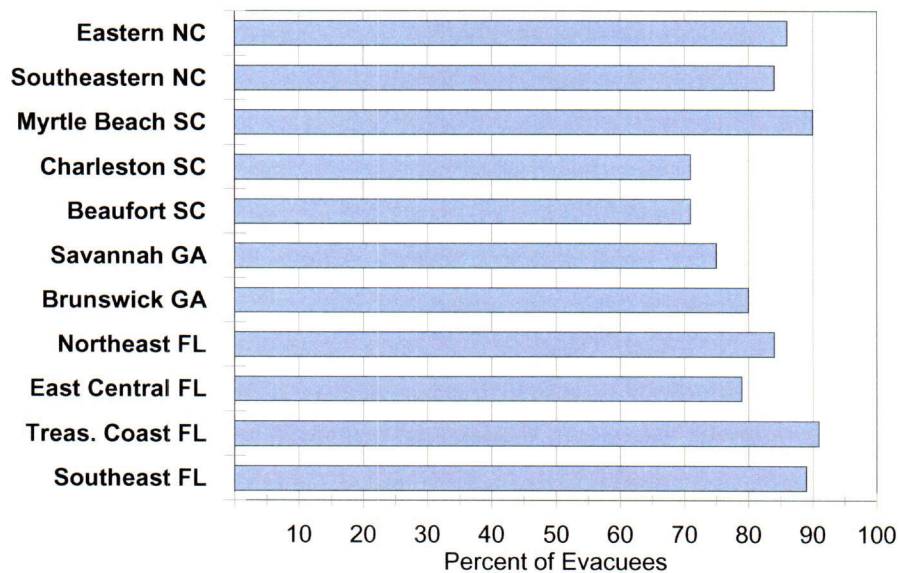


Figure 33
Heard Road Info Before Leaving Home

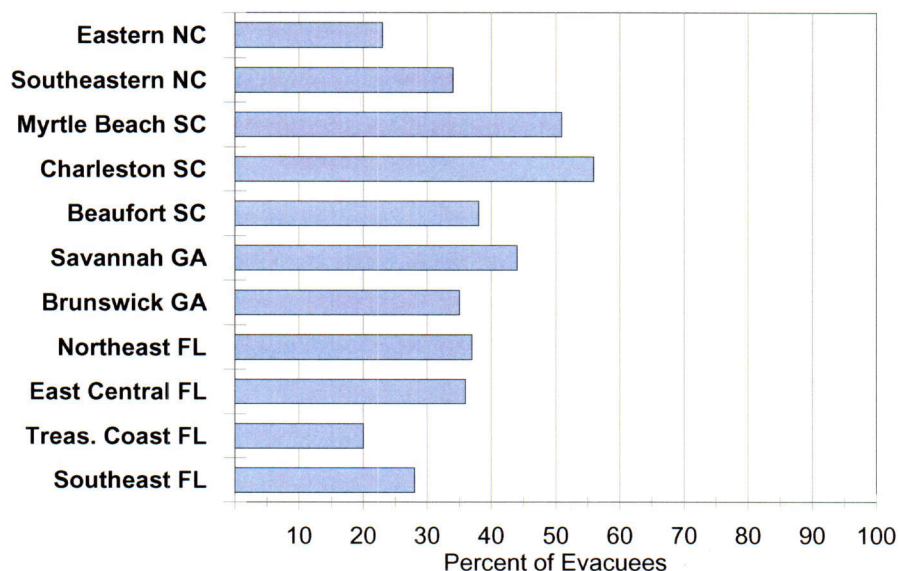


Figure 34
Heard Road Info After Leaving Home

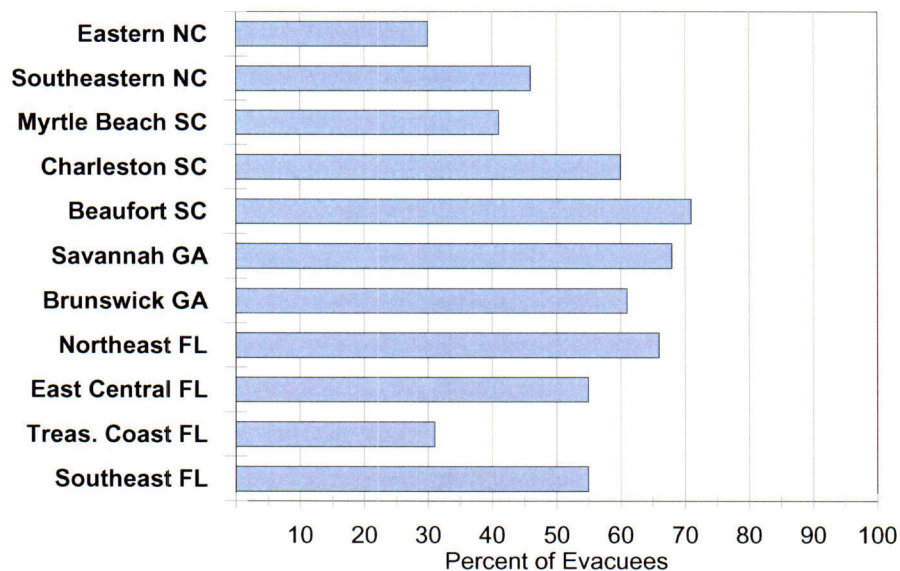
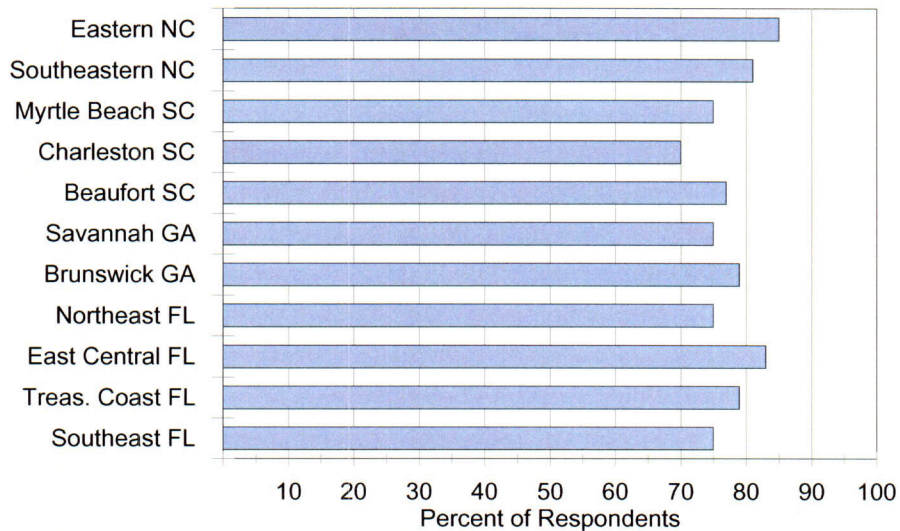


Figure 35
Would Use Longer Route If Urged
 Avg. All Zones



Next Time

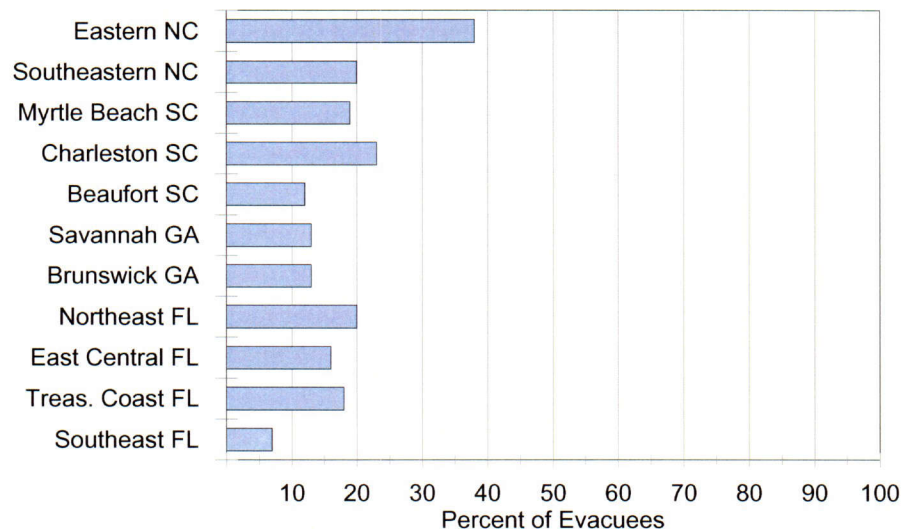
One question asked following Floyd was whether the unpleasant experiences during the evacuation would deter people from leaving in future hurricane threats. Certainly many evacuees had bad experiences, but when asked to describe the sorts of difficulties they endured, most respondents, even in Charleston, reported none, other than aggravation. The most common complaint was a lack of restroom facilities, followed by food and water. It is important for public safety officials to recognize the fact that the people who complain about events by contacting agencies, writing newspapers, and so forth don't constitute a random sample of the public.

When asked what they would do differently if faced with a similar hurricane threat in the future, fewer than 20% of the evacuees in most locations said they would not do so again (Figure 36). Some of these respondents didn't need to evacuate in Floyd, so their inclination to stay in the future is not a negative, and most of those who do need to go can be convinced

to do so in an actual threat. The most common response when asked what they would do differently was to leave earlier next time.

Figure 36

Evacuees Who Would Stay Next Time
Avg. All Zones



Recommendations:

1. Continue to use post storm assessments as the primary tool for providing behavioral data to the HES process.
2. Run scenarios with higher out-of-county evacuee percentages for strong storm clearance time calculations.
3. Capitalize on the behavioral finding by HMG that the public is willing to try phased evacuations and alternative highway routes if instructed by government officials.
4. Hold meetings to discuss ways in which the public's response/behavior can be changed through media messages so that highway congestion can be lessened.

Chapter 4

Shelter Issues

The primary objectives of shelter analyses, prepared for FEMA/Corps of Engineers comprehensive hurricane evacuation studies, are to list public shelter locations, assess their vulnerability relative to storm surge flooding, and to estimate the number of people who would seek local public shelter for a particular hurricane intensity or threat. Shelter location/capacity data are obtained from state and local emergency management staff working in conjunction with the American Red Cross, school board or other local agencies. Comparisons are then made with SLOSH data to assess flooding potential. Public shelter capacity is usually compared to public shelter demand figures generated in the transportation analysis to determine potential deficits or surpluses in sheltering. The behavioral analysis is important to this process as assumptions for the transportation analysis (regarding the percent of evacuees going to public shelter) come from the behavioral analysis or behavioral parameters recommended by the local directors.

Shelter issues related to Floyd were discussed with local and state officials. Discussions focused on the following topics:

When were shelters opened and when did evacuees arrive/stop arriving?

How many shelters were opened and how many people were sheltered?

Were any flooding, wind, or loss of power problems encountered with shelters during the storm?

Table 4-1 summarizes the responses to each of these topics gathered for the areas interviewed in Florida, Georgia, North Carolina, and South Carolina.

Shelters were opened throughout Florida in anticipation of east coast evacuees. The massive evacuation that occurred, because of the threat of Hurricane Floyd, left host counties unprepared for such shelter demand particularly for the northern part of the state. In Florida, shelters were opened as far west as Pensacola. All interviewed counties except Leon, St. Lucie, Broward, and Monroe reported having shortage of staff. Other responses included loss of utilities, shortage of shelters, shortage of food/supplies, and overcrowding. A final response, consistent throughout most of the

Table 4-1
Public Shelter Data Summary
Hurricane Floyd Evacuation Assessment

Location	Number of Shelters Opened	Number of People Sheltered	Technical Data Report Shelters/Expected Shelter Demand	Time Opened/Duration	Problems Encountered
Florida					
Nassau County	5	N/A	1,900 people	2 days	Public unaware of locations Shortage of staff Unanticipated medical problems Shortage of food/supplies
Duval County	12	5,600	7,950 people	9/14/99 1 day	Shortage of staff Shortage of cots
St. Johns County	6	1,950	3,600 people	2 days	Loss of utilities Shortage of staff Shortage of shelters
Flagler County	4	1,600	1,310 people	9/14/99 6:00 2 days	Shortage of staff Loss of utilities Shortage of food/supplies

Table 4-1 (Continued)
Public Shelter Data Summary
Hurricane Floyd Evacuation Assessment

Location	Number of Shelters Opened	Number of People Sheltered	Technical Data Report Shelters/Expected Shelter Demand	Time Opened/Duration	Problems Encountered
Florida					
Leon County	6	2,015	N/A	2 days	None reported
Volusia County	26	6,970	5,800 people	9/13/99 1 day	Public unaware of locations Overcrowding Shortage of staff Loss of utilities Security issues Shortage of shelters
Seminole County	9	2,275	1,500 people	1.5 days	Public unaware of locations Shortage of staff Shortage of food/supplies
Orange County	18	4,000	6,000 people	1 day	Public unaware of locations Shortage of shelters
Brevard County	23	7,000	8,500 people	9/13/99 4:00 PM	Shortage of staff Loss of utilities Shortage of shelters
Osceola County	6	N/A	3,800 people	24 hours	Shortage of staff
Indian River County	7	3,000	5,700 people	1 day	Shortage of staff

Table 4-1 (Continued)
Public Shelter Data Summary
Hurricane Floyd Evacuation Assessment

Location	Number of Shelters Opened	Number of People Sheltered	Technical Data Report Shelters/Expected Shelter Demand	Time Opened/Duration	Problems Encountered
Florida					
St. Lucie County	9	1,937	8,900 people	1.5 days	Professional medical staff needed at special needs shelter
Martin County	4	948	5,700 people	2 days	Shortage of staff Special needs shelter staff deficient; need medical staff
Palm Beach County	11	5,451	20,100 people	1.5 days	Overcrowding Shortage of staff
Broward County	16	5,695	28,500 people	9/13/99	None reported
Dade County	30	12,001	29,100 people	1 day	Overcrowding Shortage of staff
Monroe County	2	26	N/A	2 days	None reported

Table 4-1 (Continued)
Public Shelter Data Summary
Hurricane Floyd Evacuation Assessment

Location	Number of Shelters Opened	Number of People Sheltered	Technical Data Report Shelters/Expected Shelter Demand	Time Opened/Duration	Problems Encountered
Georgia					
Camden County	N/A	N/A	N/A	N/A	N/A
Charlton County	1	500	N/A	9/14/99 6:00 PM 1.5 days	Shortage of staff Lack of security
Glynn County	N/A	N/A	N/A	N/A	N/A
McIntosh County	N/A	N/A	N/A	N/A	N/A
Wayne County	1	120	N/A	N/A	None reported
Chatham County	4	+164	N/A	N/A	Overcrowding Shortage of staff Unanticipated medical problems Shortage of food/supplies
Liberty County	N/A	N/A	N/A	N/A	N/A
Effingham County	1	250	N/A	2 days	None reported
Bryan County	N/A	N/A	N/A	N/A	N/A
Tattnall County	1	300	N/A	9/15/99 9:00	None reported

Table 4-1 (Continued)
Public Shelter Data Summary
Hurricane Floyd Evacuation Assessment

Location	Number of Shelters Opened	Number of People Sheltered	Technical Data Report Shelters/Expected Shelter Demand	Time Opened/Duration	Problems Encountered
Cluster I					
Ware County	4	640	N/A	9/13/99 1.5 days	Public unaware of locations Shortage of staff Lack of security
Cluster II					
Emanuel County	50	3,000	N/A	2 days	Public unaware of locations Shortage of food/supplies
Treutlen County	5	750	N/A	9/13/99 10:30 PM 2 days	Public unaware of locations Shortage of staff Unanticipated medical problems
Laurens County	39	5,300	N/A	9/13/99 8:00 2 days	Shortage of staff Shortage of shelters Unanticipated medical problems Shortage of food/supplies Need specified special needs shelters Need more shelters
Dodge County	29	4,700	N/A	9/14/99 2 days	Shortage of staff Shortage of shelters Unanticipated medical problems Shortage of food/supplies Need additional shelters and special needs shelters

Table 4-1 (Continued)
Public Shelter Data Summary
Hurricane Floyd Evacuation Assessment

Location	Number of Shelters Opened	Number of People Sheltered	Technical Data Report Shelters/Expected Shelter Demand	Time Opened/Duration	Problems Encountered
Cluster II (Continued)					
Burke County	4	500	N/A	9/14/99 4:00 2 days	Public unaware of locations Shortage of staff Sleeping arrangements for people who could not sleep on the floor
Richmond County	12	5,000	N/A	25 days	Shortage of staff Lack of security Shortage of shelters
Cluster III					
Bibb County	2	4,000	N/A	N/A	N/A
Lamar County	1	8	N/A	9/15/99 12:30	Shortage of cots
Upson County	1	25	N/A	9/15/99 12:00 AM 2 days	None reported
Jasper County	N/A	N/A	N/A	N/A	Need to look for alternate shelter providers Had enough shelter space but no one to operate. Volunteers were called to other areas
Peach County	6	450	N/A	N/A	N/A
Houston County	5	6,000	N/A	9/16/99	Shortage of food/supplies Shortage of staff Unanticipated medical problems
Jones County	3	260	N/A	N/A	N/A

Table 4-1 (Continued)
Public Shelter Data Summary
Hurricane Floyd Evacuation Assessment

Location	Number of Shelters Opened	Number of People Sheltered	Technical Data Report Shelters/Expected Shelter Demand	Time Opened/Duration	Problems Encountered
Cluster III (Continued)					
Monroe County	1	160	N/A	N/A	N/A
Cluster IV					
Turner County	4	470	N/A	9/14/99 11:30PM 12 hours	Shortage of food/supplies
Wilcox County	3	175	N/A		Shortage of food/supplies
Cluster V					
Newton County	1	150	N/A	9/14/99 1:00 1 day	Public unaware of locations

Table 4-1 (Continued)
Public Shelter Data Summary
Hurricane Floyd Evacuation Assessment

Location	Number of Shelters Opened	Number of People Sheltered	Technical Data Report Shelters/Expected Shelter Demand	Timed Opened/Duration	Problems Encountered
South Carolina - Southern Conglomerate					
Beaufort County	N/A	N/A	N/A	N/A	N/A
Colleton County	4	1,606	3,600 people	9/14/99 2:00 PM 2-3 days	Loss of utilities Lack of security
Barnwell County	3	400	N/A	9/14/99 11:00 1.5 days	Public unaware of locations Shortage of staff Lack of security Shortage of food/supplies
Bamberg County	4	448	775 people	9/14/99 1:00 PM 1 day	Shortage of staff Lack of security
Orangeburg County	14	2,235	N/A	N/A	Loss of utilities Lack of security Unanticipated medical problems
Aiken County	4	1,986	5,235 people	9/14/99 11:00 1.5 days	Public unaware of locations Shortage of staff

Table 4-1 (Continued)
Public Shelter Data Summary
Hurricane Floyd Evacuation Assessment

Location	Number of Shelters Opened	Number of People Sheltered	Technical Data Report Shelters/Expected Shelter Demand	Time Opened/Duration	Problems Encountered
South Carolina Central Conglomerate					
Charleston County	13	6,362	27,250 people	9/14/99 11:00 AM 2 days	Loss of utilities No pre-staged generators
Dorchester County	9	2,676	5,160 people	9/14/99 11:00 2 days	Lack of generators Loss of utilities Shortage of food/supplies
Berkeley County	11	4,436	9,950 people	9/14/99 11:00 AM	Lack of security Additional emergency lighting
Calhoun County	2	360	850 people	9/14/99 11:00 AM 1 day	None reported
Lexington County	4	1,758	N/A	9/15/99 3:00 PM 2 days	None reported
Richland County	5	825	4,230 people	9/15/99 12:00 1 day	Public unaware of locations Security issues

Table 4-1 (Continued)
Public Shelter Data Summary
Hurricane Floyd Evacuation Assessment

Location	Number of Shelters Opened	Number of People Sheltered	Technical Data Report Shelters/Expected Shelter Demand	Time Opened/Duration	Problems Encountered
South Carolina Northern Conglomerate					
Georgetown County	2	1,395	3,450 people	9/14/99 4:00 PM 2 days	Shortage of staff Loss of utilities; no generators
Horry County	13	5,375	9,400 people	9/16/99 4:00 PM 1.5 days	Loss of utilities
Clarendon County	7	1,995	1,920 people	1 day	Shortage of staff
Sumter County	5	2,304	8,100 people	9/14/99 11:00 AM 1 day	Unanticipated Shortage of food/supplies
Florence County	5	2,385	N/A	9/14/99 12:00 2 days	Need more shelter capacity Loss of utilities; not wired for generator power
Non-Conglomerate Counties					
Greenwood county	7	54	N/A	9/14/99	Public knowing shelter locations

Table 4-1 (Continued)
Public Shelter Data Summary
Hurricane Floyd Evacuation Assessment

Location	Number of Shelters Opened	Number of People Sheltered	Technical Data Report Shelters/Expected Shelter Demand	Time Opened/Duration	Problems Encountered
Non-Conglomerate Counties (Continued)					
Lancaster County	5	459	N/A	9/15/99 6:00 PM 14 hours	None reported
Fairfield County	2	306	N/A	9/15/99 5:00 PM 2 days	None reported
Spartanburg County	2	172	N/A	9/15/99 5:00 PM 2 days	Public unaware of locations
Newberry County	1	433	N/A	9/14/99 6:00 PM 3 days	Lack of security Shortage of cots

Table 4-1(Continued)
Public Shelter Data Summary
Hurricane Floyd Evacuation Assessment

Location	Number of Shelters Opened	Number of People Sheltered	Technical Data Report Shelters/Expected Shelter Demand	Time Opened/Duration	Problems Encountered
North Carolina					
Brunswick County	4	1,400	4,450 people	9/15/99 2:00 PM 2 days	Loss of utilities
New Hanover County	3	2,600	3,800 people	9/16/99 morning 2 days	Shortage of staff Shortage of food/supplies
Pender County	3	N/A	2,500 people	9/15/99 12:00 PM 3 days	Loss of utilities Lack of security Shortage of cots and blankets
Onslow County	14	1,963	7,600 people	9/15/99 12:00 PM 2 days	Shortage of staff Loss of utilities
Carteret County	4	750	Study outdated	9/15/99 2:00 PM 1 day	Special needs shelter needed
Pamlico County	1	391	Study outdated	9/15/99 3-4 days	N/A
Beaufort County	3	1,918	Study outdated	9/15/99 3:00 PM 3 days	Overcrowding Shortage of staff Lack of security Shortage of food/supplies
Craven County	4	850	Study outdated	9/14/99 2 days	N/A

Table 4-1 (Continued)
Public Shelter Data Summary
Hurricane Floyd Evacuation Assessment

Location	Number of Shelters Opened	Number of People Sheltered	Technical Data Report Shelters/Expected Shelter Demand	Time Opened/Duration	Problems Encountered
North Carolina (Continued)					
Pitt County	5	2,200	N/A	9/14/99 1 month	Shortage of staff Loss of utilities
Dare County	N/A	N/A	Study outdated	N/A	Public unaware of locations Shortage of shelters
Currituck County	N/A	N/A	Study outdated	N/A	N/A
Edgecombe County	22	6,500	N/A	14 days	Overcrowding Shortage of staff Shortage of food/supplies Flooding Unanticipated medical problems
Lenoir County	2	2,000	N/A	1 month	Loss of utilities Communication with Hispanic population was difficult
Area I					
Chowan County	2	170	Study outdated	9/15/99 7:00 1 day	None reported
Hertford County	2	175	N/A	9/15/99 7:00 5 days	Loss of utilities

Table 4-1 (Continued)
Public Shelter Data Summary
Hurricane Floyd Evacuation Assessment

Location	Number of Shelters Opened	Number of People Sheltered	Technical Data Report Shelters/Expected Shelter Demand	Time Opened/Duration	Problems Encountered
Area II					
Martin County	4	1,500	Study outdated	9/16/99 4:00 7 days	None reported
Tyrrell County	N/A	N/A	Study outdated	N/A	None reported
Washington County	1	260	Study outdated	3:00 7.5 days	None reported
Area III					
Greene County	5	1,087	N/A	9/15/99 8:00 PM 10 days	Shortage of staff Loss of utilities
Wayne County	4	1,700	N/A	N/A	Overcrowding Difficulty with communicating to Hispanic population
Area IV					
Cumberland County	11	1,804	N/A	9/15/99 4:00 PM 1 day	Overcrowding Loss of utilities
Duplin County	7	3,500	N/A	9/15/99 7:00 PM 14 days	Overcrowding Communications

Table 4-1 (Continued)
Public Shelter Data Summary
Hurricane Floyd Evacuation Assessment

Location	Number of Shelters Opened	Number of People Sheltered	Technical Data Report Shelters/Expected Shelter Demand	Time Opened/Duration	Problems Encountered
Area IV (Continued)					
Jones County	8	650	N/A	9/15/99 5:00 PM 7 days	Loss of utilities Public unaware of locations Shortage of food/supplies
Sampson County	7	3,329	N/A	9/15/99 4:00 PM 21 hours	Overcrowding Need more approved shelters
Area V					
Bladen County	6	2,000	N/A	9/15/99 8:00 2 days	Loss of utilities
Columbus County	17	3,017	N/A	9/15/99 8:00 PM	Overcrowding Lack of security Loss of utilities Shortage of food/supplies
Hoke County	2	1,250	N/A	9/15/99 3:00 PM 1 day	Location of shelters Public question opening of local shelters
Robeson County	16	3,017	N/A	9/15/99 8:00 PM 2 day	Overcrowding Loss of utilities Shortage of food/supplies

Table 4-1 (Continued)
Public Shelter Data Summary
Hurricane Floyd Evacuation Assessment

Location	Number of Shelters Opened	Number of People Sheltered	Technical Data Report Shelters/Expected Shelter Demand	Time Opened/Duration	Problems Encountered
Area VI					
Harnett County	5	2,301	N/A	9/15/99 5:00 1 day	Need a special needs shelter
Johnston County	6	2,300	N/A	12 hours	Shortage of staff
Nash County	4	4000	N/A	9/15/99 3 days	Loss of utilities
Ware County	10	4,000	N/A	9/15/99 6:00 1 day	Overcrowding Shortage of staff

counties, was that the public was unaware of shelter locations. In the hurried response that occurs during an evacuation, the public is not aware of shelter locations. People seem to evacuate without anticipated destinations, expecting to find refuge along the way. Once the public began to evacuate, it was difficult to communicate shelter locations, opening, and closings particularly to those traveling out-of-county.

As in Florida, all threatened coastal counties evacuated except that in Georgia, the evacuation was for a Category 4 storm. This larger population flooded the inland/host counties looking for refuge. To add to this high shelter demand, evacuees from Florida and South Carolina also sought refuge throughout Georgia. Chatham County was the only coastal county with shelters opened. They had four special needs and two critical work force shelters. They experienced overcrowding, shortage of staff, unanticipated medical problems and shortage of food/supplies. Three main problems were consistently encountered by all the counties interviewed: public unaware of shelter locations, shortage of staff, and lack of availability of Red Cross shelters. Several counties, including Burke, Treutlen, and Ware, reported difficulty in providing information to evacuees on the location of shelters. As stated earlier, many evacuees were driving without a destination, and evacuees were relying on limited and constantly changing media information on shelter location. Once evacuees reached shelters, the shelters had already reached capacity or had been closed. Several I-75 corridor counties received special need's evacuees from the coast and had not been told to expect this type of shelter demand.

Counties in South Carolina had adequate numbers of shelters opened, particularly the inland counties. South Carolina, like Florida was not flooded with public shelter evacuees from other states causing unanticipated shelter demand. The most common problem encountered in South Carolina by those counties interviewed was shortage of staff, loss of utilities, and the public unaware of shelter locations. Dorchester County experienced a lack of generators, while Berkeley and Richland counties need additional emergency lighting to help with security issues such as vandalism.

North Carolina suffered unique sheltering issues compared to Florida, Georgia, and South Carolina. North Carolina's shelters were opened for long periods of time because of the extensive flooding that occurred in the state. Some areas reported to having up to 18 inches of rain due to Hurricane Florida.

The extensive flooding displaced many residents, causing shelters to be opened for up to a month in Pitt and Lenoir Counties. Another sheltering issue unique to North Carolina was the large non-English speaking migrant population. Lenoir County noted some difficulty with communications with the Hispanic population. Areas with large Hispanic populations need to provide hurricane preparedness material in Spanish. The majority of the counties noted similar problems including shortage of staff, loss of utilities, shortage of supplies, and lack of security. Also, lack of public awareness of shelter locations created a problem.

Recommendations:

1. Reduce public shelter percentages in the transportation analysis so that demand estimates are more realistic.
2. Examine public shelter locations for vulnerability to freshwater flooding.
3. Provide training/preparedness of non-American Red Cross personnel to provide shelter assistance during an evacuation.
4. Increase awareness of public shelter locations for local population prior to a hurricane season.
5. Improve communication of shelter locations and opening and closings throughout an evacuation.
6. Provide pre-season preparedness in Spanish for areas with large population of Hispanics, particularly rural areas.
7. Provide Spanish-speaking shelter personnel for those areas with large population of Hispanics.
8. Use rest stops and visitor information centers as information dissemination points for evacuees en route.
9. Provide generators to shelters due to the high number of shelters with loss of utilities.
10. Increase security at shelters in North Carolina that reported problems due to shelters being opened for extended periods of time.

Chapter 5

Transportation/Clearance Time Data

In FEMA/Corps of Engineers comprehensive hurricane evacuation studies, the primary objective of the transportation analysis is to determine the clearance times needed to conduct a safe and timely evacuation for a range of hurricane threats. Information from the vulnerability, shelter, and behavioral analyses, as well as various sources of permanent and seasonal population data, are directly input into the transportation analysis.

Except for northeast and east-central Florida, South Carolina, and portions of North Carolina, clearance times available from existing FEMA/Corps of Engineers hurricane evacuation studies were outdated. Current updates to evacuation clearance times are underway for Georgia, South Carolina and North Carolina. Updates to evacuation clearance times are sorely needed for the Treasure Coast region of Florida, all of Georgia, and most of the North Carolina coast.

Transportation and clearance time issues related to Floyd and discussed by the study teams with local and state officials included the following:

- Was the evacuation roadway network accurate - did evacuees use projected routes?
- Were any traffic control actions taken to speed up flow?
- When was the evacuation essentially completed - how long did the evacuation take?
- Were any major problems encountered in this evacuation?

Table 5-1 provides a summary of the interview responses regarding transportation and clearance times received from the various officials for the counties listed. Because differing understandings of the meaning of “clearance time” existed, the clearance times reported are approximate at best. The following is a brief, general discussion of the responses regarding traffic control actions taken and the problems encountered. Appendix E contains various traffic count graphs containing evacuation traffic versus normal daily traffic for each state.

The path of Hurricane Floyd and the uncertainty which existed regarding its potential landfall, caused massive evacuations of populations in the Florida, Georgia, South Carolina, and North Carolina coasts. These massive evacuations that occurred as a result of the uncertainty regarding anticipated landfall of Hurricane Floyd, led to the use of various traffic control actions by local and

Table 5-1
Transportation/Clearance Time Data Summary
Hurricane Floyd Evacuation Assessment

Location	Evacuation Roadway Network Accurate	Traffic Control Actions	Clearance Time Experienced	Study Calculated Time	Problems Encountered
Florida					
Nassau County	Yes	Traffic control points Roving/staffed vehicle assistance AM radio messages Re-directing traffic	N/A	10¼ hours	Unanticipated volumes Congestion/traffic jams Uncoordinated evacuation timing Inadequate signage
Duval County	Yes	Traffic control points Barricades Roving/staged vehicle assistance Coordinated traffic lights Re-directing traffic	10 hours of traffic loading/longer duration and commutes	17½ hours	Congestion/traffic jams Inadequate signage
St. Johns County	Yes	Traffic control points Barricades Locking down drawbridges Coordinated traffic lights AM radio messages	6 hours of traffic loading/longer duration and commutes	14 hours	None reported
Flagler County	Yes	Traffic control points Re-directing traffic	15 hours	17 hours	Diversions from other jurisdictions

Table 5-1 (Continued)
Transportation/Clearance Time Data Summary
Hurricane Floyd Evacuation Assessment

Location	Evacuation Roadway Network Accurate	Traffic Control Actions	Clearance Time Experienced	Study Calculated Time	Problems Encountered
Florida					
Leon County	Yes	Staged vehicle assistance Message signs Provided information on shelter and traffic at rest areas along I-10 within the county	N/A	N/a	No reliable estimate on number of people going to Leon County Unanticipated volumes
Volusia County	Yes	Traffic control points Locking down drawbridges Roving/staged vehicle assistance Coordinated traffic lights AM radio messages Message signs Re-directing traffic Conference calls with adjacent jurisdictions to coordinate evacuation times/shelter needs	14 hours	16 hours	Congestion/traffic jams Inadequate traffic control Uncoordinated traffic lights Diversions from other jurisdictions Construction
Seminole County	Yes	Traffic control points	12 hours	N/A	None reported
Orange County	Yes	Message Signs Traffic control points Redirecting traffic AM radio messages	13 hours	N/A	Congestion/traffic jams

Table 5-1 (Continued)
Transportation/Clearance Time Data Summary
Hurricane Floyd Evacuation Assessment

Location	Evacuation Roadway Network Accurate	Traffic Control Actions	Clearance Time Experienced	Study Calculated Time	Problems Encountered
Florida					
Brevard County	Yes	Barricades Traffic control points Locking down drawbridges AM radio messages Message signs	24 hours	20½ hours	Congestion/traffic jams Inadequate traffic control Uncoordinated traffic lights
Osceola County	Yes	None Reported	12 hours	N/A	None reported
Indian River County	Yes	Channel 13 broadcasts	6 hours of traffic/loading	Study outdated	Congestion/traffic jams Inadequate signage Traffic lights not coordinated Uncoordinated evacuation timing
St. Lucie County	Yes	Traffic control points Locking down drawbridges	6 hours	Study outdated	Congestion/Traffic Jams Diversions from other jurisdictions Uncoordinated traffic lights
Martin County	Yes	Traffic control points	17 hours	Study outdated	None reported

Table 5-1 (Continued)
Transportation/Clearance Time Data Summary
Hurricane Floyd Evacuation Assessment

Location	Evacuation Roadway Network Accurate	Traffic Control Actions	Clearance Time Experienced	Study Calculated Time	Problems Encountered
Florida					
Palm Beach County	Yes	Barricades Locking down drawbridges	30 hours	22½ hours	None reported
Broward County	Yes	Locking down drawbridges	not reported	N/A	Construction
Dade County	Yes	Barricades Traffic control points Locking down drawbridges	not reported	N/A	None reported
Monroe County	Yes	N/A	N/A	N/A	Need programmable message boards Need county AM/FM high power radio station

Table 5-1 (Continued)
Transportation/Clearance Time Data Summary
Hurricane Floyd Evacuation Assessment

Location	Evacuation Roadway Network Accurate	Traffic Control Actions	Clearance Time Experienced	Study Calculated Time	Problems Encountered
Georgia					
Camden County	Yes	Traffic control points Roving/staged vehicle assistance Message signs Re-directing traffic	8 hours	Study outdated	Unanticipated volumes Congestion/traffic jams Accidents Uncoordinated evacuation timing Diversion from other jurisdictions
Charlton County	Yes	Barricades Traffic control points Coordinated traffic lights AM radio messages Message signs Re-directing traffic	N/A	N/A	Congestion/traffic jams Inadequate traffic control
Glynn County	Yes	Locking down drawbridges	N/A	Study outdated	Uncoordinated traffic lights Uncoordinated evacuation timing Diversion from other jurisdictions
McIntosh County	Yes	None reported		Study outdated	None reported
Wayne County	Yes	N/A	12 hours	N/A	Congestion/traffic jams
Chatham County	Yes	Reversing highways Traffic control points Coordinated traffic lights	27 hours	Study outdated	National Guard needed for traffic control Traffic information from other states would be helpful
Liberty County	Yes	Traffic control points Message signs	28 hours	Study outdated	Unanticipated volumes Congestion/traffic jams
Effingham County	Yes	N/A	30 hours	Study outdated	Unanticipated volumes Inadequate traffic control Uncoordinated evacuation timing

Table 5-1 (Continued)
Transportation/Clearance Time Data Summary
Hurricane Floyd Evacuation Assessment

Location	Evacuation Roadway Network Accurate	Traffic Control Actions	Clearance Time Experienced	Study Calculated Time	Problems Encountered
Georgia (Continued)					
Bryan County	Yes	Traffic control points Barricades	10 hours	Study outdated	Unanticipated volumes Congestion/traffic jams
Tattnal County	Yes	N/A	18 hours	N/A	Need alternate evacuation routes Congestion/traffic jams
Cluster I					
Ware County	Yes	Barricades Traffic control points Roving/staged vehicle assistance Coordinated traffic lights Message signs Redirecting traffic	24 hours	N/A	Uncoordinated evacuation timing Diversion from other jurisdictions Intersection of 3 major evacuation routes need better flow. Potential roadway flooding of routes Unanticipated volumes Inadequate signage
Cluster II					
Emanuel County	Yes	Traffic control points AM radio messages Redirecting traffic	48 hours	N/A	Unanticipated volumes Congestion/traffic jams Uncoordinated traffic lights Diversion from other jurisdictions Uncoordinated evacuation timing Evacuation routes may flood
Treutlen County	Yes	Barricades Traffic Control Points Roving/staged vehicle assistance Reversing highways Message signs Redirecting traffic	48 hours	N/A	Diversion from other jurisdictions Unanticipated volumes Congestion/traffic jams Accidents Inadequate signage Inadequate traffic control Uncoordinated traffic lights Uncoordinated evacuation timing

Table 5-1 (Continued)
Transportation/Clearance Time Data Summary
Hurricane Floyd Evacuation Assessment

Location	Evacuation Roadway Network Accurate	Traffic Control Actions	Clearance Time Experienced	Study Calculated Time	Problems Encountered
Cluster II (Continued)					
Laurens County	Yes	Barricades Traffic Control Points Roving/staged vehicle assistance Reversing highways Message signs Redirecting traffic	48 hours	N/A	Better communications with evacuees on route Unanticipated volumes Congestion/traffic jams Inadequate signs
Dodge County	Yes	Barricades Traffic Control Points Roving/staged vehicle assistance Message signs Redirecting traffic	N/A	N/A	Unanticipated volumes Better communications with evacuees on route
Burke County	Yes	Traffic Control Points Redirecting traffic Trained 13 EMT students to help with traffic control	N/A	N/A	Unanticipated volumes Congestion/traffic jams Uncoordinated evacuation timing Inadequate signage Need to better inform evacuees on route
Richmond County	Yes	Traffic control points TV/messages Road signs	N/A	N/A	Inadequate signage Need more traffic control points
Cluster III					
Bibb County	Yes	None reported	N/A	N/A	
Lamar County	Yes	None reported	N/A	N/A	Difficulty getting information to evacuees on route

Table 5-1 (Continued)
Transportation/Clearance Time Data Summary
Hurricane Floyd Evacuation Assessment

Location	Evacuation Roadway Network Accurate	Traffic Control Actions	Clearance Time Experienced	Study Calculated Time	Problems Encountered
Cluster III (Continued)					
Upton County	Yes	None reported	N/A	N/A	None reported
Jasper County	Yes	None reported	N/A	N/A	Need to look for alternate routes Unanticipated volumes Diversion from other jurisdictions
Peach County	Yes		N/A	N/A	N/A
Houston County	Yes	None reported	36 hours	N/A	Unanticipated volumes Uncoordinated traffic lights Uncoordinated evacuation timing Diversion from other jurisdictions Inadequate signage
Jones County	Yes	N/A	N/A	N/A	N/A
Monroe County	Yes	N/A	N/A	N/A	N/A
Cluster IV					
Turner County	Yes	None reported	14 hours	N/A	None reported
Wilcox County	Yes	Traffic control points	16 hours	N/A	None reported
Cluster V					
Newton County	Yes	Traffic control points	N/A	N/A	Congestion/traffic jams Evacuees need to receive better information

Table 5-1 (Continued)
Transportation/Clearance Time Data Summary
Hurricane Floyd Evacuation Assessment

Location	Evacuation Roadway Network Accurate	Traffic Control Actions	Clearance Time Experienced	Study Calculated Time	Problems Encountered
South Carolina Southern Conglomerate					
Beaufort County	N/A	Barricades Traffic control points Locking down draw bridges Roving/staged vehicle assistance Coordinated traffic lights Message signs	24 hours	20 hours	Congestion/traffic jams Inadequate traffic control
Colleton County	N/A	Traffic control points Roving/staged vehicle assistance Message signs	N/A	20 hours	Congestion/traffic jams
Barnwell County	N/A	Traffic control points Coordinated/traffic jams	N/A	N/A	Unanticipated volumes Congestion/traffic jams Diversion from other jurisdictions Inadequate signage
Bamberg County	N/A	Traffic control points Coordinated traffic lights Redirecting traffic	N/A	N/A	Unanticipated volumes Congestion/traffic jams Inadequate traffic control Uncoordinated evacuation timing
Orangeburg County	N/A	Traffic control points	N/A	N/A	Unanticipated Volumes Congestion/traffic jams Uncoordinated traffic lights Uncoordinated evacuation timing

Table 5-1 (Continued)
Transportation/Clearance Time Data Summary
Hurricane Floyd Evacuation Assessment

Location	Evacuation Roadway Network Accurate	Traffic Control Actions	Clearance Time Experienced	Study Calculated Time	Problems Encountered
Aiken County	N/A	Traffic control points Roving/staged vehicle assistance Message signs	N/A	N/A	Unanticipated volumes Congestion/traffic jams Accidents Inadequate traffic control Gridlock on Highway 278 and Highway 125
South Carolina Central Conglomerate					
Charleston County	N/A	Traffic control points Locking down drawbridges Coordinated traffic lights AM radio messages Message signs Re-directing traffic Reversing highways	20+ hours	22 hours	Unanticipated volumes Congestion/traffic jams Inadequate traffic control Uncoordinated traffic lights
Dorchester County	N/A	Traffic control points Redirecting traffic	20-22 hours	22 hours	Unanticipated volumes Congestion/traffic jams
Berkeley County	N/A	N/A	N/A	22 hours	Congestion/traffic jams
Calhoun County	N/A	Traffic control points	N/A	N/A	Need more evacuation route signs Unanticipated volumes Congestion Inadequate traffic control
Lexington County	N/A	Traffic control points	N/A	N/A	Congestion/traffic jams
Richland County	N/A	Message signs	N/A	N/A	Unanticipated volumes

Table 5-1 (Continued)
Transportation/Clearance Time Data Summary
Hurricane Floyd Evacuation Assessment

Location	Evacuation Roadway Network Accurate	Traffic Control Actions	Clearance Time Experienced	Study Calculated Time	Problems Encountered
South Carolina Northern Conglomerate					
Georgetown County	N/A	Traffic control points Coordinated traffic lights AM radio messages	13 hours	20 hours	Congestion/traffic jams
Horry County	N/A	Barricades Traffic control points Locking down drawbridges Message signs Roving/staged vehicle assistance Coordinated traffic lights Re-directing traffic	17 hours	20 hours	Congestion/traffic jams Accidents Inadequate traffic control
Clarendon County	N/A	Barricades Traffic Control points Coordinated traffic lights Message sings Redirecting traffic	N/A	N/A	Congestion/traffic jams Diversion from other jurisdictions
Sumter County	N/A	Roving/stage vehicle assistance AM radio message Message signs	N/A	N/A	None reported
Florence County	N/A	Traffic control points	4 hours	N/A	None reported

Table 5-1 (Continued)
Transportation/Clearance Time Data Summary
Hurricane Floyd Evacuation Assessment

Location	Evacuation Roadway Network Accurate	Traffic Control Actions	Clearance Time Experienced	Study Calculated Time	Problems Encountered
Non-Conglomerate Counties					
Greenwood County	N/A	Traffic control points Roving/staged vehicle assistance	N/A	N/A	None reported
Lancaster County	N/A	None reported	N/A	N/A	None reported
Fairfield County	N/A	Roving/staged vehicle assistance	N/A	N/A	None reported
Spartanburg County	N/A	None reported	N/A	N/A	None reported
Newberry County	N/A	Message signs	N/A	N/A	None reported

Table 5-1(Continued)
Transportation/Clearance Time Data Summary
Hurricane Floyd Evacuation Assessment

Location	Evacuation Roadway Network Accurate	Traffic Control Actions	Clearance Time Experienced	Study Calculated Time	Problems Encountered
North Carolina					
Brunswick County	Yes	Traffic control points Radio broadcasts at intersection	5 hours	8¼ hours	Bottlenecks of I-95 and I-40
New Hanover County	Yes	Traffic control points Coordinated traffic lights	8 hours	7¼ hours	Congestion/traffic jams Flooded roads Inadequate signage
Pender County	Yes	Traffic control points Locking down drawbridges	9 hours	6¼ hours	Diversions from other jurisdictions Unanticipated volumes
Onslow County	Yes	Traffic control points Message signs	10 hours	7¼ hours	None reported
Carteret County	Yes	Traffic control points Message signs Barricades Locking down drawbridges Coordinated traffic lights	8 hours	N/A	None reported
Pamlico County	Yes	N/A	N/A	N/A	N/A
Beaufort County	Yes	Barricades Traffic control points Roving/staged vehicle assistance Redirecting traffic	N/A	N/A	Congestion/traffic jams Flooded roads

Table 5-1 (Continued)
Transportation/Clearance Time Data Summary
Hurricane Floyd Evacuation Assessment

Location	Evacuation Roadway Network Accurate	Traffic Control Actions	Clearance Time Experienced	Study Calculated Time	Problems Encountered
North Carolina					
Craven County	Yes	None reported	N/A	N/A	None reported
Pitt County	Yes	None reported	N/A	N/A	Flooding
Dare County	Yes	Traffic control points Locking down draw bridges Roving/staged vehicle assistance Coordinated traffic lights Message signs Re-directing traffic	8 hours	N/A	Inland construction slowed evacuation Diversion from other jurisdictions
Currituck County	Yes	Traffic control points Message signs	12 hours	N/A	Congestion/traffic jams
Edgecombe County	Yes	None reported	24 hours	N/A	Flooding
Lenoir County	Yes	N/A	N/A	N/A	Flooded roads Congestion/traffic jams
Georgia					
Chowan County	Yes	N/A	N/A	N/A	N/A
Hertford County	Yes	Message signs Traffic control points	N/A	N/A	Construction on Hwy 17 bridge Flooded roads

Table 5-1 (Continued)
Transportation/Clearance Time Data Summary
Hurricane Floyd Evacuation Assessment

Location	Evacuation Roadway Network Accurate	Traffic Control Actions	Clearance Time Experienced	Study Calculated Time	Problems Encountered
Area II					
Martin County	Yes	Traffic control points Message signs	N/A	N/A	Congestion/traffic jams Uncoordinated evacuation timing
Tyrrell County	Yes	Traffic control points Locking down drawbridges Message signs	6 hours	N/A	Congestion/traffic jams Accidents
Washington County	Yes	Traffic control points AM radio messages Message signs	N/A	N/A	Flooded roads
Area III					
Greene County	Yes	Barricades Redirecting traffic	N/A	N/A	Flooded roads
Wayne County	Yes	N/A	N/A	N/A	N/A
Area IV					
Cumberland County	Yes	None reported	14 hours	N/A	None reported
Duplin County	Yes	None reported	N/A	N/A	None reported
Jones County	Yes	Traffic control points	N/A	N/A	None reported

Table 5-1 (Continued)
Transportation/Clearance Time Data Summary
Hurricane Floyd Evacuation Assessment

Location	Evacuation Roadway Network Accurate	Traffic Control Actions	Clearance Time Experienced	Study Calculated Time	Problems Encountered
Area IV (Continued)					
Sampson County	Yes	Barricades Re-directing traffic	N/A	N/A	Unanticipated volumes due to closing of I-40 in Duplin
Area V					
Bladen County	Yes	None reported	N/A	N/A	Flooded roads
Columbus County	Yes	Traffic control points Message signs Re-directing traffic	5 hours	N/A	Accidents Inadequate traffic control Construction
Hoke County	Yes	None reported	7 hours	N/A	None reported
Robeson County	Yes	Traffic control points Roving/staged vehicle assistance AM radio messages Redirecting traffic	5 hours	N/A	Congestion/traffic jams Accidents Flooded roads Construction Diversion from other jurisdictions
Area VI					
Harnett County	Yes	None reported	N/A	N/A	None reported
Johnston County	Yes	Traffic control points	N/A	N/A	None reported
Nash County	Yes	Traffic control points	12 hours	N/A	None reported
Ware County	Yes	None reported	N/A	N/A	None reported

state officials. The same frustrations were generally reported in all jurisdictions with limited variations found in some counties, generally the result of higher population densities in those areas. In Florida, counties generally reported that manning traffic control points, re-direction of traffic and locking down drawbridges were the most common traffic control actions amongst those taken. Other traffic control actions included coordinated traffic lights in St. Johns County and the use of barricades in Palm Beach and Dade Counties to ease the flow of the evacuation traffic. Problems encountered were primarily unanticipated volumes of evacuees and diversions of evacuees from other jurisdictions into their jurisdictions. Duval, Nassau and Indian River Counties reported that inadequate roadway signage was a problem. Several counties encountered additional problems such as uncoordinated traffic lights, inadequate traffic control, uncoordinated evacuation timings, and diversions from other jurisdictions.

Figure 5-1 compares the evacuation traffic versus normal daily traffic at I-10 and the CR 217 overpass south of Baldwin in Duval County for a five-day period. The high volumes of traffic experienced on I-10 during the evacuation are illustrated by Figure 5-1 of September 13 through 17, 1999. This graph indicates more than 3,000 vehicles per hour for a twelve hour period on Tuesday, September 14, 1999. This was during the evacuation phase of Duval County. Traffic was practically non-existent on September 15 after evacuation had taken place, and again increased on September 16 and 17 during re-entry; however, the traffic counts seen indicate that re-entry was more orderly. This would be expected in view of the reduced urgency involved in re-entry.

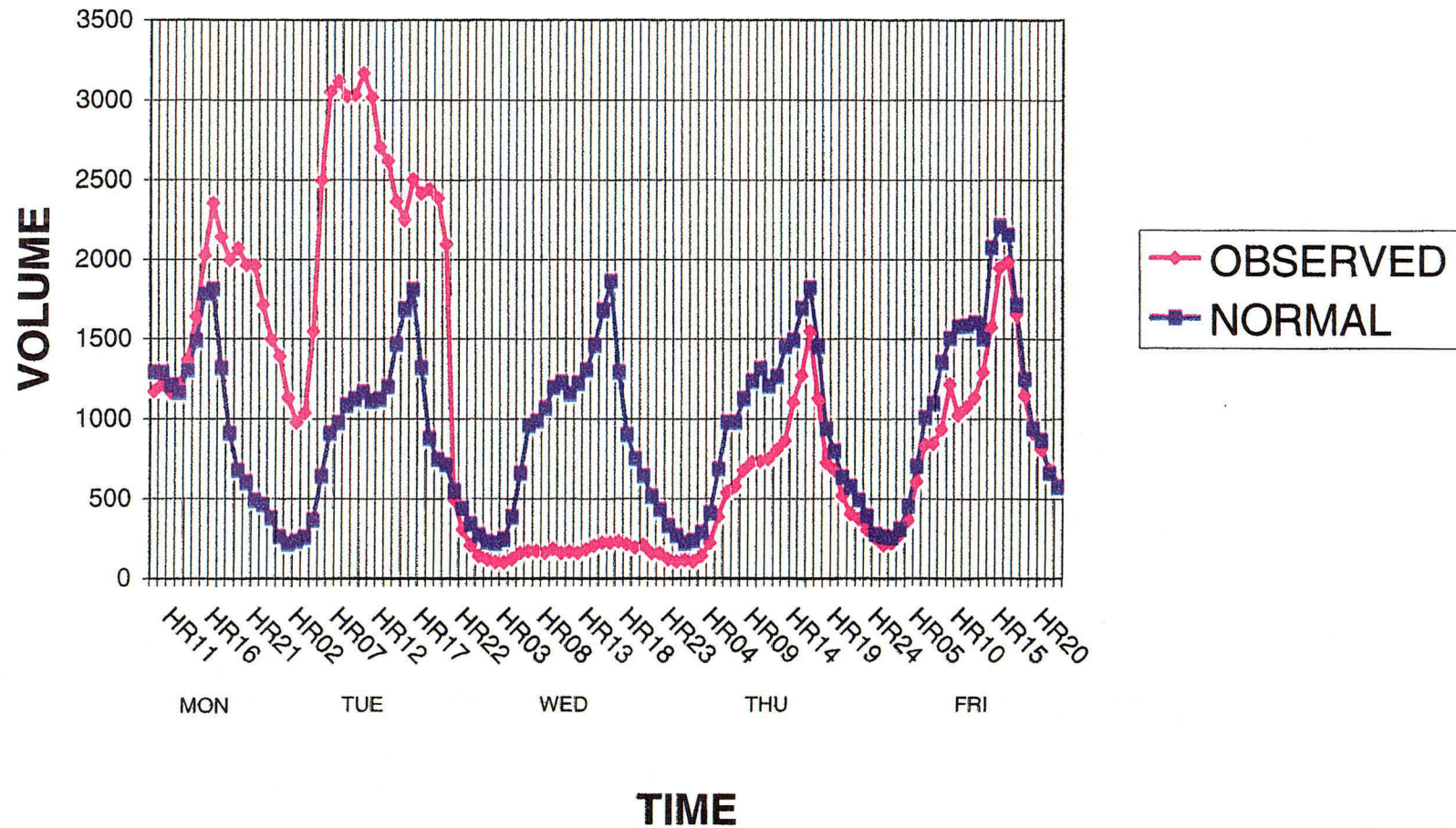
As in Florida, Georgia officials reported manning of traffic control points as the most commonly noted action. Other reported traffic control actions included the use of barricades, locking down drawbridges and redirecting traffic. One interesting initiative was that the state, in conjunction with the officials of Chatham County, reversed traffic lanes on I-16, thereby greatly increasing westbound capacity. Counties, such as Camden, Charlton, Ware, and Richmond, used message signs to keep evacuees informed. Similar problems were encountered in Georgia as in Florida, including unanticipated traffic volumes, diversions from other jurisdictions, and uncoordinated evacuation timings. Also, several counties such as Laurens and Dodge noted difficulties in communicating with evacuees.

Figure 5-1

WEST BOUND TRAFFIC ON I-10

SITE 109 @CR217 OVERPASS S. OF BALDWIN, DUVAL CO.

HURRICANE FLOYD (SEPTEMBER 13-17, 1999)



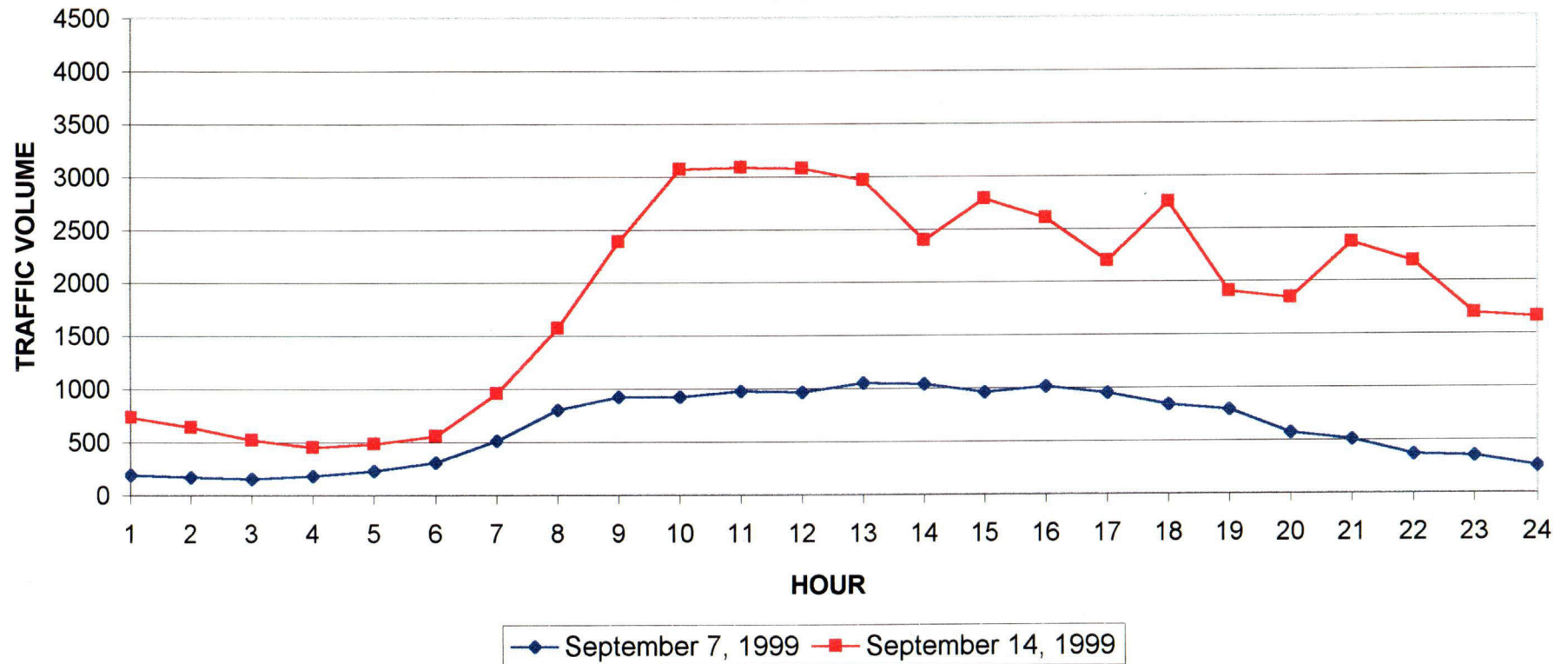
Traffic control actions were taken by South Carolina officials as in Florida and Georgia. Traffic control actions were taken such as locking down of bridges, coordination of traffic lights, and re-direction of traffic. Most of South Carolina counties reported the use of traffic control points. Richland and Clarendon Counties used message signs while Charleston County informed the public not only through message signs but also AM Radio.

Most counties encountered unanticipated volumes and diversions from other jurisdictions. As in Florida and Georgia, problems encountered were generally the result of unanticipated traffic volumes and evacuees from evacuating counties causing congestion and problems to counties located in their evacuation paths. A particular traffic gridlock was reported in Aiken County at highways 278 and 125. A variety of other problems were encountered, again similar to those in the other states, such as inadequate traffic controls, uncoordinated traffic lights, and congestion. As previously done for I-10 in Florida, traffic volumes on I-26 westbound at Bowman from I-95 to Columbia, were compared to normal traffic counts of September 7, 1999 to actual traffic reported during the evacuation period on September 14, 1999. The comparison is represented by Figure 5-2. This graph indicates that on September 14, 1999, the day most counties ordered evacuations, traffic volume remained at a 2,500 to 3,000 vehicle per hour level for a twelve hour period. This compared to less than a thousand vehicles per hour on non-evacuation days. This compares exactly with the vehicle volume experienced on I-10 in Florida during the day of actual evacuation for that area.

North Carolina had similar experiences to the other states except for the amount of roadway flooding that occurred. North Carolina had already been saturated by Hurricane Dennis a few weeks prior to the arrival of Hurricane Floyd. Hurricane Floyd, a Category 2 storm once it reached North Carolina, made landfall near Cape Fear and moved up the eastern coast leaving in its path up to 18 inches of rain in some areas. The large amounts of rainfall caused major road closings due to flooding, making re-entry a difficult task. Most counties including New Hanover, Beaufort, Pitt and Edgecombe experienced flooding as the main problem encountered during the evacuation. Construction impacted Hertford, Columbus, and Robeson Counties. Manning of traffic control points was the most common traffic control action noted. However, other actions taken were message signs in Onslow and Dare Counties and redirecting traffic in Sampson and Columbus

Figure 5-2

Sta. 20 I-26 W @ Bowman
From I-95 (mp 169) to Columbia



Counties. I-40 and College Road in Wilmington had tremendous congestion due to too many evacuees trying to load the road network in a very short period of time.

A major issue identified in the interview process was high volumes of traffic from other jurisdictions impacting the road network. With the exception of south Florida that began evacuating first, each state had a major impact on the evacuation of the other states. Never has such a massive peacetime evacuation taken place in the United States. Those areas that had recent hurricane evacuation studies (HES) were satisfied with the clearance times and understood the unique situation that Hurricane Floyd created. However, individual commute times for households were surprisingly high to the public, causing a great deal of negative public opinion concerning management of the evacuation.

Recommendations:

1. Improve communications with evacuees while en route by providing traffic information at rest areas or through radio.
2. Provide a tool to help emergency managers anticipate evacuation traffic coming from other jurisdictions or states.
3. Work with each state's DOT to provide local emergency managers "real-time" traffic count information.
4. Calculate and report worst household commute times in addition to clearance times for each storm scenario.
5. Run clearance time calculations for reverse lane operations.
6. Provide traffic condition thresholds which would trigger implementation of various traffic control alternatives.
7. Work with USDOT and the state DOT's to implement ITS to facilitate evacuations.
8. Run clearance time scenarios with larger out-of-county percentages and greater participation on inland counties.

Chapter 6

Decision Making

Some of the most important products developed as part of the FEMA/Corps of Engineers hurricane evacuation studies and delivered to local and state officials have been evacuation decision making tools. These tools are decision arc maps and tables, as well as computer software such as HURWIN 95. These products graphically tie real-time storm characteristics with HES produced hazards, shelter and clearance time data. Their purpose is to give emergency management directors a means of retrieving Technical Data Report information without having to dig through a report during an emergency. Evacuation decision tools provide guidance and assistance to decision makers as to when an evacuation should begin relative to a specific hurricane, its associated wind field, forward speed, probabilities, forecast track, and intensity.

Discussions initiated by the FEMA/Corps study teams with local and state officials regarding the evacuation decision process focused on the following questions:

When was the Emergency Operating Center fully activated and what prompted this decision?

What study products/decision aides were used to decide when to evacuate and who should evacuate? Was HURWIN 95 product used?

When was the evacuation order or request made?

Table 6-1 provides a summary of the responses and information gathered from each county. Most areas interviewed used similar products: HURREVAC, HURWIN 95, decision arcs, zone maps and surge maps. Those that did not have HURREVAC or HURWIN 95 used HURRTRAC or other commercial products.

Counties interviewed in Florida use HURWIN 95. HURWIN 95 is a WINDOWS 95 based version of DOS HURREVAC. It was developed based on findings from previous Post Storm Assessment Studies where local emergency managers requested that HURREVAC be updated to a WINDOWS platform. Several counties reported that they need more training using HURWIN 95 including Nassau, Duval, St. Johns, Flagler, Seminole, and Monroe. The SLOSH display program is also widely used by several counties.

Table 6-1
Evacuation Decision Process Summary
Hurricane Floyd Evacuation Assessment

Location	Time EOC Was Activated	What Prompted Decision to Activate	What Study Products/Decision Aids Were Used in Decision Making	Time of Evacuation Order/Number Evacuated	How Well Study Products Worked
Florida					
Nassau County	9/13/99 12:00 AM		SLOSH TIDES National Weather Service Northeast FL Evacuation Study	9/14/99 9:00 AM	Good experience with products Need HURWIN training Pleased with technical data of HES HLT briefing
Duval County	9/13/99 8:15 AM		DOS HURREVAC GDS Inland winds Decision ARCS SLOSH TIDES TAOS	9/14/99 7:00 75,000 -100,000	Good experience with products Need more training
St. Johns County	9/13/99 10:00 AM		DOS HURREVAC HURRTRAK SLOSH	9/14/99 8:00 AM 35,000-55,000	HURREVAC and HURRTRAK not on site. Information sent to EOC from the RPC Need more training
Flagler County	9/13/99 3:15 AM		SLOSH Decision ARCS HURWIN 95	9/14/99 6:00 10,000	Excellent experience with HURWIN 95 Need more training
Leon County	9/14/99 2:00 PM		HURRTRAK GDS	N/A	Good experience with products

Table 6-1 (Continued)
Evacuation Decision Process Summary
Hurricane Floyd Evacuation Assessment

Location	Time EOC Was Activated	What Prompted Decision to Activate	What Study Products/Decision Aids Were Used in Decision Making	Time of Evacuation Order/Number Evacuated	How Well Study Products Worked
Florida					
Volusia County	9/13/99 8:00 AM		Inland winds Decision ARCS HURRTRAK SLOSH TAOS	9/14/99 6:00 AM 133,000	Good experience with products SLOSH need refinement detail for man-made features and depth of water
Seminole County	9/13/99 8:30 AM		HURWIN 95 Inland winds HURRTRAK	9/14/99	Need better rainfall forecasting tool Need more training
Orange County	9/14/99 8:00 AM		HURWIN 95 Inland winds	9/14/99 6:00 AM 80,000	Manuals and "Help" menus need improvement
Brevard County	9/13/99 8:00 AM		HURWIN 95 HURRTRAK	9/13/99 4:00 PM	Excellent experience with products
Osceola County	9/13/99 8:30 AM		HURWIN 95 HURRTRAK Inland winds TAOS	N/A	No comment

Table 6-1 (Continued)
Evacuation Decision Process Summary
Hurricane Floyd Evacuation Assessment

Location	Time EOC Was Activated	What Prompted Decision to Activate	What Study Products/Decision Aids Were Used in Decision Making	Time of Evacuation Order/Number Evacuated	How Well Study Products Worked
Florida					
Indian River County	9/14/99 7:00 AM		SLOSH TIDES TAOS National Hurricane Center Model HURREVAC	9/14/99 7:00 AM 10,000	HURREVAC needs improvement - estimated wind arrival time off by 6 hours
St. Lucie County	9/13/99 3:00 PM		HURRTRAK SLOSH	9/13/99 6:00 PM 25,000	Need HURWIN 95 training
Martin County	9/13/99 11:00 AM		HURWIN 95 Decision ARCS HURRTRAK SLOSH TIDES	9/13/99 4:00 PM 80,000	Update SLOSH study to address GIS mapping
Palm Beach County	9/14/99 11:00 AM		HURWIN 95 Decision ARCS HURRTRAK	9/13/99 7:00 PM	Good experience with products
Broward County	9/13/99 1:00 PM		HURWIN 95 HURRTRAK GDS SLOSH Internet products	9/13/99 175,000	Need to update behavioral analysis HURRTRAK graphics better than HURWIN for faxing

Table 6-1 (Continued)
Evacuation Decision Process Summary
Hurricane Floyd Evacuation Assessment

Location	Time EOC Was Activated	What Prompted Decision to Activate	What Study Products/Decision Aids Were Used in Decision Making	Time of Evacuation Order/Number Evacuated	How Well Study Products Worked
Florida					
Dade County	9/12/99		HURWIN 95 Inland winds Decision ARCS SLOSH TIDES TAOS (Limited)	N/A	Improve description and display of wind field data
Monroe County	9/13/99 4:00 PM		HURWIN 95 Decision ARCS SLOSH TIDES	N/A	SLOSH model needs improvement Need more training

Table 6-1 (Continued)
Evacuation Decision Process Summary
Hurricane Floyd Evacuation Assessment

Location	Time EOC was Activated	What Study Products/Decision Aids Were Used in Decision Making	Time of Evacuation Order/Number Evacuated	How Well Study Products Worked
Georgia				
Camden County	9/14/99 5:00 PM	DOS HURREVAC Inland winds SLOSH TIDES	9/14/99 12:00 PM 41,650	Excellent products Could use a laptop computer to deliver information from tools to officials when needed
Charlton County	9/14/99 10:00 AM	DOS HURREVAC HURWIN 95 Inland winds	9/14/99 10:00 AM	Need more training
Glynn County	Not reported	HURWIN 95 Inland winds SLOSH	9/14/99 8:15 AM	Good experience with products. Difficulty at times communicating with liaison team
McIntosh County	Not reported	DOS HURREVAC Inland winds SLOSH	Not reported	Excellent products Would like more training
Wayne County	Not reported	HURWIN 95 Inland winds	9/14/99 12:00 4,000	Excellent experience with products Need more training. Would like alternative site to download data
Chatham County	9/13/99 6:00 PM	HURWIN 95 Decision ARCS HURRTRAK	9/14/99 12:00 PM 215,000	Need SLOSH & HURWIN 95 training Rainfall feature in HURWIN would be great
Liberty County	9/13/99 8:00 AM	HURWIN 95 Inland winds Decision ARCS SLOSH TIDES	9/14/99 2:00 PM	Conference calls worked well Excellent rating of products

Table 6-1 (Continued)
Evacuation Decision Process Summary
Hurricane Floyd Evacuation Assessment

Location	Time EOC was Activated	What Study Products/Decision Aids Were Used in Decision Making	Time of Evacuation Order/Number Evacuated	How Well Study Products Worked
Georgia (Continued)				
Effingham County	Not reported	HURWIN 95 Inland winds Conference calls	9/14/99 6:00 PM +3,000	Products worked well
Bryan County	9/14/99 8:00 PM	HURWIN 95 Inland winds SLOSH TIDES	9/14/99 3:00 PM 20,000	Good products Hurricane study SLOSH Maps were very useful
Tattnal County	Not reported	HURWIN 95 Inland winds	9/14/99 5:00 1,000	Excellent experience with products Needs more training Would like alternative site to download data
Florida				
Ware County	9/13/99 6:00 PM	DOS HURREVAC HURWIN 95 Inland winds	9/14/99 6:00 AM	Inland counties need more training Would like rainfall prediction model
Georgia II				
Emanuel County	N/A	HURWIN 95	N/A	N/A
Treutlen County	N/A	None reported	N/A	N/A
Laurens County	N/A	HURWIN 95	N/A	N/A
Dodge County	N/A	HURWIN 95	N/A	Satisfied with products

Table 6-1 (Continued)
Evacuation Decision Process Summary
Hurricane Floyd Evacuation Assessment

Location	Time EOC was Activated	What Study Products/Decision Aids Were Used in Decision Making	Time of Evacuation Order/Number Evacuated	How Well Study Products Worked
Cluster II (Continued)				
Burke County	9/14/99 3:00	HURWIN 95 Inland winds US Navy Rorsats NOAA	N/A	Good experience with products Difficulties logging on to download data
Richmond County	Practical activation	N/A	N/A	N/A
Cluster III				
Bibb County		HURWIN 95 Inland winds Teleconferences		Products worked well
Upson County	12:00 AM			
Lamar County	N/A	Inland winds NWS Hurricane liaison team	N/A	Need to get HURWIN 95 Excellent experience with products
Jasper County	9/15/99 9:00	Inland winds DTN	N/A	Satisfied with products
Peach County	Not reported	HURWIN 95 Inland winds Teleconferences	N/A	Products worked well
Houston County	Not reported	HURWIN 95 Inland winds	N/A	Need more training

Table 6-1 (Continued)
Evacuation Decision Process Summary
Hurricane Floyd Evacuation Assessment

Location	Time EOC was Activated	What Study Products/Decision Aids Were Used in Decision Making	Time of Evacuation Order/Number Evacuated	How Well Study Products Worked
Cluster III (Continued)				
Jones County	N/A	N/A	N/A	N/A
Monroe County	N/A	N/A	N/A	N/A
Cluster IV				
Turner County	Not reported	DTN	N/A	Need HURWIN 95 and training
Wilcox County	Not reported	DTN	N/A	Need HURWIN 95 and training
Cluster V				
Newton County	9/14/99	HURWIN 95 Inland winds	N/A	Good experience with products Need HURWIN 95 and training

Table 6-1(Continued)
Evacuation Decision Process Summary
Hurricane Floyd Evacuation Assessment

Location	Time EOC was Activated	What Prompted Decision to Activate	What Study Products/Decision Aids Were Used in Decision Making	Time of Evacuation Order/Number Evacuated	How Well Study Products Worked
South Carolina Southern Conglomerate					
Beaufort County	N/A	N/A	HURWIN 95 SLOSH	N/A	Wind radi on HURRWIN not accurate enough
Colleton County	9/15/99	N/A	DOS HURREVAC HURWIN 95 Inland winds	9/14/99 12 PM	Could not get hurricane updates quickly enough
Barnwell County	9/13/99 9:00	N/A	HURWIN 95	9/14/99 7:00 PM	Excellent experience with product /
Bamberg County	N/A	N/A	Inland winds	9/14/99 11:00 AM	Consider product satisfactory
Orangeburg County	N/A	N/A	HURWIN 95 Inland Winds	N/A	Improve wind speed forecast for inland winds Forecast model for rainfall/time effects
Aiken County	N/A	N/A	Intelicast.com Weather tropical HURRTRAK I	N/A	Need training on variety of products

Table 6-1 (Continued)
Evacuation Decision Process Summary
Hurricane Floyd Evacuation Assessment

Location	Time EOC was Activated	What Prompted Decision to Activate	What Study Products/Decision Aids Were Used in Decision Making	Time of Evacuation Order/Number Evacuated	How Well Study Products Worked
South Carolina Central Conglomerate					
Charleston County	9/12/99 6:00 PM	N/A	HURWIN 95 TIDES Inland winds Decision ARCS SLOSH maps	9/14/99 12:00	SLOSH maps need improvements Over estimation of wind speeds
Dorchester County	9/13/99	N/A	HURWIN 95 Inland winds Decision ARCS	9/14/99 12:00	Update South Carolina data in HURWIN 95 Winds are over-predicted
Berkeley County	9/12/99 2:00 PM	N/A	HURWIN 95 SLOSH TIDES	9/14/99 12:00	SLOSH mapping is poor Excellent experience with HURWIN 95
Calhoun County	9/13/99 9:00 AM	N/A	HURWIN 95	N/A	Excellent experience with HURWIN 95 Need more training
Lexington County	9/15/99 6:00 PM	N/A	HURWIN 95	N/A	Excellent experience with product
Richland County	9/14/99 8:00	N/A	HURWIN 95	9/15/99 5:00	Good experience with HURWIN 95

Table 6-1 (Continued)
Evacuation Decision Process Summary
Hurricane Floyd Evacuation Assessment

Location	Time EOC was Activated	What Prompted Decision to Activate	What Study Products/Decision Aids Were Used in Decision Making	Time of Evacuation Order/Number Evacuated	How Well Study Products Worked
South Carolina Northern Conglomerate					
Georgetown County	9/13/99 3:00 PM	N/A	HURWIN 95 DTN	9/19/99 12:00 20,000	Wind fields are exaggerated, especially on weak side Need more training
Horry County	9/15/99 8:00 AM	N/A	HURWIN 95 TIDES DTN	9/16/99 12:00 PM	Would like to step down storm category Quick download time of updates
Clarendon County	N/A	N/A	HURWIN 95	N/A	Excellent experience with product
Sumter County	N/A	N/A	HURWIN 95 Inland winds	N/A	Would like a rainfall model
Florence County	9/14/99 6:00 PM	N/A	HURWIN 95	N/A	Excellent experience with HURWIN 95 Wind speeds are too high

Table 6-1 (Continued)
Evacuation Decision Process Summary
Hurricane Floyd Evacuation Assessment

Location	Time EOC was Activated	What Prompted Decision to Activate	What Study Products/Decision Aids Were Used in Decision Making	Time of Evacuation Order/Number Evacuated	How Well Study Products Worked
South Carolina Non-Conglomerate Counties					
Greenwood County	9/14/99 2:00	N/A	Inland winds	N/A	Excellent experience
Lancaster County	N/A	N/A	DTN	N/A	Weather radars were excellent Direct phone communication was excellent
Fairfield County	9/15/99 5:00 PM	N/A	Inland winds	N/A	Over-prediction of wind speeds Would like to have a rainfall prediction model
Spartanburg County	9/15/99 9:30	N/A	Inland winds	N/A	Satisfactory rating of inland winds
Newberry County	9/14/99 6:00 PM	N/A	N/A	N/A	N/A

Table 6-1 (Continued)
Evacuation Decision Process Summary
Hurricane Floyd Evacuation Assessment

Location	Time EOC was Activated	What Prompted Decision to Activate	What Study Products/Decision Aids Were Used in Decision Making	Time of Evacuation Order/Number Evacuated	How Well Study Products Worked
North Carolina					
Brunswick County	9/15/99 7:00 AM	N/A	HURWIN 95 Inland winds Decision ARCS EM2000 Surge maps	9/15/99 4:30 PM 6,000	Complimentary towards HLT Needs HURWIN 95 training Excellent experience with Decision ARCS
New Hanover County	9/16/99 4:00 AM	N/A	HURWIN 95 DTN	9/16/99 6:00 AM 12,000-15,000	Excellent experience with HURWIN 95 Would like combined information on rainfall & storm surge
Pender County	9/15/99 8:00 AM	N/A	HURWIN 95 Inland winds SLOSH DTN	9/15/99 9:00 AM	More accurate inland wind information
Onslow County	9/13/99 6:00 AM	N/A	HURWIN 95 Inland winds Decision ARCS SLOSH TIDES	9/15/99 7:00 AM	Inland wind accuracy questioned Incorporate database that would reveal tidal flooding Improve mapping capability to account for storm surge and rain data along river basin
Carteret County	9/14/99 5:00 AM	N/A	HURWIN 95	9/15/99 10:00 AM 35,000	Overestimation of wind arrival
Pamlico County	N/A	N/A	N/A	N/A	N/A

Table 6-1 (Continued)
Evacuation Decision Process Summary
Hurricane Floyd Evacuation Assessment

Location	Time EOC was Activated	What Prompted Decision to Activate	What Study Products/Decision Aids Were Used in Decision Making	Time of Evacuation Order/Number Evacuated	How Well Study Products Worked
North Carolina					
Beaufort County	9/15/99 8:00	N/A	HURWIN 95 HURRTRAK SLOSH EM2000	9/15/99 3:00 PM 1,200	HURWIN 95 need improvement - long time to get update of data More training necessary
Craven County	9/14/99 12:00	N/A	HURWIN 95 Inland winds	9/15/99	Hurricane forecast updates closer apart than 6 hours
Pitt County	9/15/99	N/A	HURWIN 95 Inland winds EM 2000	N/A	Need training in EM 2000 Difficulty in downloading updates for HURWIN 95 due to high volumes of users
Dare County	N/A	N/A	HURWIN 95 Decision ARCS HURRTRAK SLOSH TIDES	50,000	Would like "point and click" flood surge determination More county specific on predicted flooding potential from given category storm
Currituck County	9/14/99 8:00 AM	N/A	HURWIN 95 Inland winds Decision ARCS HURRTRAK SLOSH TIDES	9/15/99 10:00 AM 18,000	Good experience with products
Edgecombe County	9/16/99 2:00PM	N/A	DOS HURREVAC HURWIN 95	N/A	Need HURWIN 95 training

Table 6-1 (Continued)
Evacuation Decision Process Summary
Hurricane Floyd Evacuation Assessment

Location	Time EOC was Activated	What Prompted Decision to Activate	What Study Products/Decision Aids Were Used in Decision Making	Time of Evacuation Order/Number Evacuated	How Well Study Products Worked
Lenoir County	9/17/99 11:00 AM	N/A	HURWIN 95 Inland winds	9/16/99 2:00 AM	Would like rainfall model Overestimate of wind field overland Firm maps need to be updated
Area I					
Chowan County	9/15/99 7:00 AM	N/A	HURWIN 95	N/A	Over-prediction of wind speeds
Hertford County	9/14/99 5:00 PM	N/A	HURWIN 95	N/A	Over-prediction of wind speeds
Area II					
Martin County	9/16/99 5:00 PM	N/A	HURWIN 95 Inland winds SLOSH	9/16/99 5:00 PM	Would like to see rainfall forecast model Need more training
Tyrrell County	9/15/99 8:00 PM	N/A	HURWIN 95 Decision ARCS	N/A	Need more training
Washington County	9/15/99 3:00	N/A	HURWIN 95 TIDES	N/A	Excellent experience with both products Would like a rainfall forecast model Need more training
Area III					
Greene County	9/15/99 6:00	N/A	DOS HURREVAC HURWIN 95 Inland winds	9/16/99 2:00 PM 1,800	Exaggerated wind speeds and fields
Wayne County	N/A	N/A	N/A	N/A	N/A

Table 6-1 (Continued)
Evacuation Decision Process Summary
Hurricane Floyd Evacuation Assessment

Location	Time EOC was Activated	What Prompted Decision to Activate	What Study Products/Decision Aids Were Used in Decision Making	Time of Evacuation Order/Number Evacuated	How Well Study Products Worked
Area IV					
Cumberland County	9/15/99 3:00	N/A	HURWIN 95 Internet	9/15/99 12:00	HURWIN 95 was user friendly A users manual for HURWIN 95
Duplin County	9/15/99 7:00 AM	N/A	DOS HURREVAC HURWIN 95 Inland winds DTN Conference calls Local weather Internet	9/17/99 2:30 PM	Need more training
Jones County	9/15/99 7:00 AM	N/A	HURWIN 95 Inland winds Internet Conference calls DTN	9/15/99 12:00 PM 600	Need more HURWIN 95 training
Sampson County	9/15/99 3:00 PM	N/A	HURWIN 95 Inland winds	9/15/99 4:00 PM	Good experience with products

Table 6-1 (Continued)
Evacuation Decision Process Summary
Hurricane Floyd Evacuation Assessment

Location	Time EOC was Activated	What Prompted Decision to Activate	What Study Products/Decision Aids Were Used in Decision Making	Time of Evacuation Order/Number Evacuated	How Well Study Products Worked
Area V					
Bladen County	N/A	N/A	DOS HURREVAC Inland winds	N/A	Good experience with products
Columbus County	9/15/99 3:00 PM	N/A	DOS HURREVAC HURWIN 95 DTN Inland winds Decision ARCS	9/15/99 5:00 PM	Need better wind field prediction
Hoke County	9/15/99 3:00 PM	N/A	HURWIN 95 Inland winds DTN Decision ARCS	9/15/99 5:00 PM	Excellent experience with product
Robeson County	9/15/99 4:00 PM	N/A	DOS HURREVAC HURWIN 95 Inland winds Decision ARCS DTN	9/15/99 5:00 PM 3,000	Unsatisfactory experience with inland winds because winds were not depicted properly Intermediate advisory needs to be published

Table 6-1 (Continued)
Evacuation Decision Process Summary
Hurricane Floyd Evacuation Assessment

Location	Time EOC was Activated	What Prompted Decision to Activate	What Study Products/Decision Aids Were Used in Decision Making	Time of Evacuation Order/Number Evacuated	How Well Study Products Worked
Area VI					
Harnett County	9/15/99 11:00 AM	N/A	HURWIN 95	N/A	Good experience with product
Johnston County	9/15/99	N/A	DOS HURREVAC HURWIN 95 Inland winds SLOSH	N/A	Need more training Need better wind field information
Nash County	9/15/99 3:00 PM	N/A	None used	3,000	None reported
Ware County	9/15/99 7:00	N/A	DOS HURREVAC HURWIN 95 Inland winds HURRTRAK	N/A	Need more training

As in Florida, most of the counties interviewed in Georgia used HURWIN 95, SLOSH, and Inland winds. Other products used included TIDES, Decision ARCS and DTN. Turner, Lamar and Wilcox Counties need the HURWIN 95 product and training. Similar to counties in Florida, Houston County noted that they need more HURWIN 95 training along with McIntosh and Charlton Counties.

Counties interviewed in South Carolina responded similarly to those in Florida and Georgia. South Carolina counties used HURWIN 95 as the primary decision making tool. Several counties, including Beaufort, Charleston and Berkeley, used the available SLOSH maps. Charleston and Berkeley Counties would like to see improvements to the SLOSH maps, particularly regarding the topo bases used. As in Florida and Georgia, HURWIN 95 training is also needed in South Carolina. Georgetown and Calhoun Counties noted that more HURWIN 95 training is necessary.

Most of the counties interviewed in North Carolina reported using either HURWIN 95 or DOS HURREVAC. As in Florida, Georgia, and South Carolina, several counties, such as Brunswick, Edgecombe, and Tyrell, need more HURWIN 95 training. Cumberland County noted that a users manual for HURWIN 95 would be useful since training is not often and HURWIN 95 is only used during a potential hurricane threat to an area.

Overall, there is satisfaction with the FEMA/Corps products, particularly HURWIN 95. Three major requested enhancements stood out throughout the interview process in all four states. One is a rainfall forecasting component to HURWIN95. This module would help local emergency managers anticipate the storm's predicted rainfall.

The second enhancement to HURWIN 95 is better reporting and estimation of the wind fields, particularly on the western part of the storm. Local emergency managers commented on the over estimation of the wind fields. Since the National Hurricane Center produces this product and HURWIN 95 just displays it, the enhancement will have to involve discussions with NOAA to resolve the issue.

The third major enhancement to HURWIN 95 would be the ability to receive “real time” traffic count information during an evacuation. Emergency managers would like to have a better idea of the traffic volumes from other jurisdictions to anticipate needs such as sheltering, public information, and evacuation timing. Whether this would be done through HURWIN 95 or some other tool needs to be discussed.

Recommendations:

1. Conduct more training sessions with local EMS’ regarding the HURWIN 95 model.
2. Develop a rainfall forecasting component to HURWIN 95.
3. Enhance INLAND WINDS model to better predict wind fields.
4. Encourage NOAA to work on models to improve the wind field forecasting.
5. Explore possibility of adding real-time traffic count information to HurrWin95 or another tool.

Chapter 7

Public Information

Although not a major part of previous FEMA/Corps of Engineers hurricane evacuation study efforts, public information is recognized as an important final element that must be addressed. Study products and data must ultimately be tailored to a format that the media and general public can understand so that correct evacuation decisions and preparations can be made at the household level. The Floyd event showed how the public currently receives hurricane evacuation information. Floyd also provided local and state officials with an opportunity to assess additional needs regarding public information.

Methods used and suggestions offered in the study areas to inform the public in Floyd and future events included the following:

1. Public information brochures were developed and widely distributed early in the season showing vulnerable areas, evacuation levels, and tips on hurricane preparedness.
2. Press briefing with national and local media to insure that they (radio, TV, newspapers) disseminate consistent information to the public - Media were given packets of hurricane materials early in the season by some emergency officials.
3. "Media Day" prior to hurricane season was held in many areas to make the media aware of local process during an evacuation.
4. Law enforcement officials drove through neighborhoods with sirens and P.A. systems to encourage people to evacuate.
5. Some communities were able to provide evacuation information to the public through printed information in the local phone book.
6. An important means was through radio and television - some communities used cable TV overrides to alert the public of evacuation advisories and provide Public Service Announcements.
7. The Weather Channel was used extensively by local emergency management staff and citizens for public education and information.
8. Some counties used their web sites to display storm information and advisories.

9. Some emergency management officials faxed advisory and teleconference information to media every six hours.
10. Decision arc systems are good for public and school education as they are easy to understand.
11. County public information officers are important resources during the event to interface with the media and public.
12. There is a mixture of ideas from the media regarding "canned" HES media products. Many would rather develop their own graphics.
13. Some selected areas would like hurricane information in Spanish.
14. There is need for better coordination between the media and EOC during a storm.
15. Improve evacuation zone maps distributed to the public by better delineating zones
16. Variable message signs or information provided while public in evacuating.
17. The public needs travel information regarding route choice and expected commute times.

Appendix A

Meeting Attendees/Persons Providing Input In Affected Areas

**HURRICANE FLOYD
MEETING PARTICIPANTS
1999-2000**

FLORIDA

NAME

Sheila Premo
Michael Loehr
Rodger Menzies
Linda Stoughton
Steve Letro
Billy Wagner
Jon Gillinger
Eric Gentry
Bill Crippen
Tom Castiglia
William E. Lefevre
Bill Sander
Miller Norton
Al Elmore
Lt. Mike McElreath
Mark Daniels
Rick Ball
Fred Johnson
Bill Dorough
Jim Coker
Kevin Northington
Joe Lewis
Edgar Smith
Betty Ingram
Conni Vandenabeele
Sal Magaddino
Mitch Stamitoles
Debra Van Merkestyn
Carolyn Abell
Doug McKelvey
Andy Sikes
Robert McIntyre
Lew Eason
Daniel Salmon
Linda Ottinger
Steve Letro

ORGANIZATION

PBS&J
FDEM
USACE - Savannah Dist.
SJCEM
NUS Jax
FEMA
EM Div. Ch.
Director - EMS
Dir. DOH
American Red Cross
FL National Guard
ARES
ARES
ARES
FHP
Parks & Recreation
Co.of Jax. Traffic Engineer
NWS Jax
Emergency Preparedness
ITD
ITD Telecomm.
City of Jax Beach
Property Appraiser
Emg. Prep Div/City of Jax.
Duval Co. Schools
Emg. Prep.
FL DOT
Mayo Clinic
Emg. Prep.
JEA
Duval Co. EOC
Nassau Co. Solid Waste
Risk Manager
Bldg Maintenance
911/Sheriff's Office
NWS Jacksonville

**HURRICANE FLOYD
MEETING PARTICIPANTS (Continued)
1999-2000**

FLORIDA

NAME

Wiley Page
Liz Flaisig
Alice Mattimore
Mike Lyons
Sal Magaddino
Bill Dorough
Morrison Braren
Sharon Agentz
Richard Smith
Phil Rivers
Gress Hickman
Doug Wright
Nathan McCollum
Michelle Pope
Deanie Lowe
Randy Ast
Joe Daly
Ellen Newton
Paul Minshew
Fred Miller
Keith Riger
Don Land
John Carleton
Ted Evens
Kevin Gray
Lawrence Schumaker
Sergio Pachew
Chris Loomis
J. Ryan
Tom Sivert
Ginger Nogueira
Tracey Barlow
Ron Burch
Bob Lay
Don Daniels
John Gonzales

ORGANIZATION

PBS&J
News-Leader Nassau Co.
Nassau Co.
WJXT-TV 4

Emg. Prep.
Emerg. Prep.
Mayor's Office
EM Director
Leon Co. Sheriff's Office
USACE-Mobile
Indian River Co. EM
Indian River Co. EM
FL DEM
ESF-15
Holly Hill
Edge Water
American Red Cross
VC Health Dept.
School Bd ESF 1
City of Deland
Ponce Inlet
Port Orange
South Daytona
City of Ormond Beach
Edgewater
Animal Services
Volusia Co. Fire
Volusia Co. EM
Vol. Co. Utilities
Vol. Co. Public Works
City of Edgewater
Brevard Co. EM-Coordinator
Brevard Co. EM Dir.
St. Lucie Co. EM
Pt. St. Lucie Public Works

**HURRICANE FLOYD
MEETING PARTICIPANTS (Continued)
1999-2000**

FLORIDA

NAME

Nancy Ingle
Tom Christopher
Gregg Wyatt
Terry Barcelona
H.D. Savage
Mary Dutro
Charlie Neeld
Betty De Stefano
William Moore
Kevin Yelvington
Joe McCluan
Kent Baxter
Osman Aloyo
Patrick Odom
Freddie Vargas
Doug Harvey
Richard Hill
Debra McCaughey
Linda Ryan
Kathleen Leahy
Wayne Duffy
Melvin Baxley
Keith Holman
Jerry Smith
Henry Johnson
Tom Billinston
Pedro Pico
John Murphy
Sheridan Truesdale
Helen Wetherington
Terry Rowe
Chuck Suits
John Snow
Lucy Keely
Randy Sheppans
Brian Hanley
Robert Smith

ORGANIZATION

Ft. Pierce Public Works
St. Lucie Co. EM
WPSL & WPSL.COM
Ft. Pierce Police Dept.
St. Lucie Co. Sheriff
St. Lucie Co. EM
WPSL
American Red Cross
OC EM
Osceola Co. F/R
Seminole Co.
FEMA Region VI
O.C. OEM
FDEM
PBS&J
Town of Jupiter Island
USACE
City of Stuart
Martin Co. Health Dept.
MCEM
City of Stuart
Martin Co. EM
Martin Co. EM

Martin Co. Fire Rescue
Martin Co. Fire Rescue
FEMA Comm. Relations
Palm Tran
PBC EM Management
PBC EM
PBSO
PBC P10
City of West Palm Beach EM
PBC EM
PBC FireRescue
PBC EM
FEMA

**HURRICANE FLOYD
MEETING PARTICIPANTS (Continued)
1999-2000**

FLORIDA

NAME

James Loshine
Michael Hardin
Tony Carper
Paulette Newman
Jack Schnettler
Carlos Lozada
Myra Delgado
Bill Johnson
I. Rezola
Vilma Vela
Erle Peterson
Walt Peacock
Cathie Perkins
Shari Holbert Lipner
Chuck Lanza
Thomas Cullen
Capt. Jerry Holmes
Irene Toner
Jerald O'Cathey

ORGANIZATION

NWS
Broward Co EM
Broward Co EM
BR EM
PBS&J
Miami OEM
MDHD
Miami Dade DEM
American Red Cross
Miami-Dade OEN
Miami-Dade OEN
FL Int. Un.
MD OEM
MDFRD
MDOEM
MCO EM
Salvation Army
MCO EM
MCO EM

**HURRICANE FLOYD
MEETING PARTICIPANTS
1999-2000**

GEORGIA

NAME

Will Hardin
N.H. Sanderson
Delwyn Kinsley
Richard Hill
Christy Palin
Garfield Jones
Dan Lewis
Cindy Perry
Ed Abel
Ray Parker
Bob Sprinkel
Tom Burriss
Lamar Crosby
Allan McDuffie
Walter B. Stewart
Vernon Rushing
Gress Hickman
Rodger Menzies
Will Brothers
Jack Hullo
Jack Hobbs
Dave Dwgocenski
Michael Strobridge
Ezra Price
Jerry Odom
Sid Love
Don Bryant
Walter Hull
Lisa Peebles
Ray Woods
Sam Van Arsdale
Steve Carter
Jayne Brinson

ORGANIZATION

Camden Schools
FEMA
Camden Co. EMA
USACE
PBS&J
American Red Cross
Camden Co. SO
American Red Cross
Glynn Co. EMA
McIntosh Co. EMA
Deputy Director
Liberty Co. EMA
Effingham Co.
USACE
EMS & EMA - Effingham
Bryan Co. EMA Director
USACE Mobile
USACE Savannah
PBS&J
GEMA Field Coord.
Ware Co. EMA
Richmond Co. EMA Dir.
Swainsboro Fire Dept.
Emanuel Co. Adm.
Swainsboro Fire Dept
Trenthlen Co. EMA
Laurens Co. EMA
Emanuel Co. DFCS
Emanuel Co. DFCS
Emanuel Co. Board of Ed.
Emanuel Co. Rd. Supt.
Emanuel Co. EMA
Burke Co. EMA

**HURRICANE FLOYD
MEETING PARTICIPANTS (Continued)
1999-2000**

GEORGIA

NAME

Jim Guny
Chuck Kay
Millard Joiner
Pat Collins
Billy Mitcham
Edward Westbrook
Vickie Thompson
Jimmy Williams
Mill Dowd
Hope Andrews
Allan Green
James Defoe
E L Joiner
John Tumes
Gene Field
Thomas Doles
JD Hull
Chuck Bobo
Dan Brown
Jack Hutto
Allen Robinson
Ollie McGahee
Newt S. Bigger
Gracia Szczech
Charles Dawson
Don Lewis
Heather Houston
William Winn
Chuck Gregg
Pete Nichols
Dan Stowers
Clayton Scott
Mike Fagler

ORGANIZATION

Burke Co. EMA
GA EMA
Dodge Co. EMA Dir.
MCA News
Thomaston EMA
Jasper Co. EMA
GEMA
Houston Co. EMA
USACE-Charleston
Lamar Co. EMA
Jones Co. EMA
Bibb Cp. SD
Macon PD
Macon Co. EMA
Macon Bibb EMA
Peach Co. EMA
EMA

Tattnall EMA
GEMA Field Coord.
Wayne Co EMA
Wayne Co. EMA
Newton Co EMA
GEMA-GA
GEMA-GA
PBS&J
PBS&J
FEMA
GEMA
Chatham Co. Commission
Chatham Co. EMA
Chatham Co. EMA
GA State Patrol

**HURRICANE FLOYD
MEETING PARTICIPANTS (Continued)
1999-2000**

GEORGIA

NAME

Clayton Scott
Robert Oliver
Al Bungard
Cindy McGinnis
Phillip Webber
Bo Todd
Glenn Trout

ORGANIZATION

EMA
Chatham Co. Police
Chatham Co. Engr
Chatham Co. Transit
EMA
EMA Director
Ass. Dir. EME

**POST HURRICANE FLOYD
MEETING PARTICIPANTS
2000**

SOUTH CAROLINA

NAME

Richard Hill
William Winn
John Smith
Greg Sox
Norman Knight
Wes Blanchard
Robert Smith
Will Brothers
Ken Harrell
Paul D. Whitten
NH Sanderson
Allan McDuffie
Christy Palin
Henrietta Alleman
Billy Wagner
Stan McKinney
Charmel Menzel
John Knight
Don Lewis
Ron Osborne
Dusty Owens
Dennis Clark
John Eringman
Suzanne Gant
Linda Woods
Otis L. Rhodes
John Barnwell
Cindy Smith
George Malone
Neil W. Ellis
John Trulock

ORGANIZATION

US Army Corps of Engineers
Beaufort County, Directory EMD
Orangeberg County, Directory EPA
Richland County Emergency Preparedness
Calhoun County, Director EPA
Berkeley County, Director EMD
FEMA
PBS&J
Dorchester County, Director Emergency Services
Horry County, Director EPD
FEMA
US Army Corps of Engineers
PBS&J
FEMA
FEMA
SCEPD
SCEPD
SCEPD
PBS&J
SCEPD
Florence County, Director EPD
Charleston County, Director EPD
US Army Corps of Engineers
Colleton County, Director EPA
Town of Edisto Beach
Walterboro Police Dept.
Colleton County Dept. of Social Services
American Red Cross
Colleton County Sheriff
Lexington County, EPD Coordinator
Clarendon County, Director DPA

*Participation during the scheduled South Carolina meetings was limited due to the snow event.

**POST HURRICANE FLOYD
MEETING PARTICIPANTS
2000 (Continued)**

SOUTH CAROLINA

NAME

Luis Dugan
Bruce Barkley
Joy Allen
Jeff Jowers
John Angil
David Ruth
Mike Kirkland
Blakie Shute
Victor Jones
Herbert Vaughan
C. Holt

ORGANIZATION

Georgetown County, Director EPD
WOLO TV-Columbia, SC
WOLO TV - Columbia, SC
Bamberg County, Director of CCDA
Barnwell County, Director of Emergency Services
Aiken County, Coordinator of DEP
Fairfield County, Director EMD
Lancaster County, Coordinator EPA
Sumter County, Public Safety Director
Greenwood County, Director EPA
Spartanburg County, Director EPD

*Participation during the scheduled South Carolina meetings was limited due to the snow event.

**POST HURRICANE FLOYD
MEETING PARTICIPANTS
2000**

NORTH CAROLINA

NAME

Jason Williams
Gary Faltinowski
Allan McDuffie
Billy Zwerschke
Don Lewis
Paul Karch
N.H. Sanderson
Cecil Logan
Tom Collins
Dan Summers
Lisa Moon
Doug Haas
Carson Smith
Karen Wagley
Doug Bass
Mitchell Parker
Roger Dail
Kathy Gray
Ken Pate
Heather Houston
Mill Dowd
Stanley Kite
Tim Harvey
Carol Wentworth
Jenny Lassiter
Mike Addertion
Chris Coudriet
Stan White
Terry Wheeler
Geneva Perry
Jessica Phillis
Dorothy Toolan
Roger Lambertson
Robert Smith
Stanley D. Griggs
J. Mims

ORGANIZATION

NCEM-Planning
NCEM-Planning
US Army Corps of Engineers
FEMA
PBS&J
US Army Corps of Engineers
FEMA
Brunswick County EMA
NCEM Area 5
New Hanover County
PBS&J
NCEM
Pender County EM
Onslow County EM
Onslow County EM
Onslow County
LCEM
LCEM
LCEM
PBS&J
USACE-Charleston
Craven County EM
Pamlico EM
American Red Cross
Pamlico Co. Health Dept.
Carteret County
NCFEM-Planning
Dare County
Dare County
Dare County
Dare County
Dare County Public Information
Currituck County Public Info.
FEMA - HLT
Currituck EM
Currituck Fire Prevention

**POST HURRICANE FLOYD
MEETING PARTICIPANTS
2000 (Continued)**

NORTH CAROLINA

NAME

David Humphrey
Judy Jordan-Payment
Ron Wall
James Mercer
Wiley Page
William Winn
Gress Hickman
Edward L. Garrison
James McCotter
Tom Pohlman
Bobby Joyner
Tabitha Mills
Mac Manning
Daden Wolfe
Aileen Hardison
Ginny Williams
Tamara Hower Williams
Don Davenport
Alan Jordan
Douglas Belch
Charles B. Jones
Tony Rogers
Ann Keyes
Buddy Swan
Dickie Hill
Thomas Rowe
Joe Gurley
Mel Powers
Ronald Bass
Dorothy M. Cavenaugh
Carol F. Tyndall
Jim Barnhardt
Jane Price
Jimmy Jackson
Kay Nelson

ORGANIZATION

NCEM-Operations Field Staff
Currituck EM
NCEM
Edgecombe County
PBS&J
FEMA
US Army Corps of Engineers - Mobile
Pitt County Social Services
Pitt County ES
East Carolina University
Pitt County ES
Pitt County ES
Pitt County Sheriff
EM
DSS
Beaufort County Health Dept.
Beaufort County Health Dept.
County Manager
Sheriff
Chowan County ES
Hertford County
Martin County EM
Washington County EM
Tyrrell County EM
Greene County EM
Wayne County
Wayne County EM
Wayne County EM
Sampson County EM
Duplin County EM
Jones County EM
Duplin County Manager
Fairmont
Columbus County Fire Marshal
Columbus County ES

**POST HURRICANE FLOYD
MEETING PARTICIPANTS
2000 (Continued)**

NORTH CAROLINA

NAME

ORGANIZATION

Mitchell Byrd	Bladen County ES
Al Schwarcbher	Hoke County ES
David Carter	Robeson EM
Scott Elliott	County Manager
Marc Sessoms	E-911 Communications
Mattie Caulder	Robeson EM
DeWayne West	Johnston County
Martin Chrisca	Wake County
Scott Rogers	Nash County
Brian McFeaters	Wake County
Gary Pope	Harnett County
Joan Parker	Harnett County
Bob Williams	News & Observer
Robert Murray	FOX 8-WGHP-TV8
Ellen Reinhardt	NC News Network
Julia Lewis	WRAL-TV5
Angela Starke	ABC 45 News
Tom Hegele	NCEM-CIO
Sandra L. Smith	WBO-EM
Danny Gee	Area 15
Ron Campbell	Area 10
Darlene M. Johnson	ES
Jeff Cardwell	NCEM
Jimmie Ramsey	NCEM
Sylvia Griffin	NCEM
Frances B. Frech	NCEM
Ed Cash	NCEM
Paul Denison	NCEM Area 6
James Smith	EBO Manager
Cathy Henry	NCEM Area 3
Tim Miller	NCEM WBO
Amy Ikerd	NCEM - Asst HS Coordinator
Tina Howard	NCEM
Bill Gentry	NCEM

Appendix B

National Hurricane Center's Hurricane Floyd
Warning Summary/Timetable and Best Track Data

Preliminary Report **Hurricane Floyd** **7 - 17 September, 1999**

Richard J. Pasch, Todd B. Kimberlain and
Stacy R. Stewart
National Hurricane Center
18 November 1999

Floyd was a large and intense Cape Verde hurricane that pounded the central and northern Bahama islands, seriously threatened Florida, struck the coast of North Carolina and moved up the United States east coast into New England. It neared the threshold of category five intensity on the Saffir/Simpson Hurricane Scale as it approached the Bahamas, and produced a flood disaster of immense proportions in the eastern United States, particularly in North Carolina.

a. Synoptic History

Floyd can be traced back to a tropical wave that emerged from western Africa on 2 September. This system was not particularly impressive-looking, in terms of the organization of the convection shown on satellite images, but there was evidence of curvature in the cloud lines. Overall the system was broad and disorganized, yet easily recognizable as a synoptic-scale entity.

The wave proceeded westward across the eastern tropical Atlantic at about the normal speed of propagation, 6 degrees of longitude per day, with little apparent change, for several days. A center of circulation was estimated late on 5 September near 15N 32.5W but the cloud pattern lacked sufficient deep convection for a Dvorak classification. On 6 September, there was enough of a curved band of deep convection present so that the system was classified as a T1.0 on the Dvorak scale around 1200 UTC. A

favorable upper-level outflow pattern existed over the area, and the cloud pattern became more consolidated and better organized on the 7th. Tropical Depression Eight formed about 1000 miles east of the Lesser Antilles by 1800 UTC that day.

A deep-layer ridge prevailed to the north of the cyclone and the associated steering current moved the system west-northwestward at 12-15 knots for a couple of days. When it reached a position about 750 n mi east of the Leeward Islands, the cloud pattern became sufficiently well organized for the system to become Tropical Storm Floyd around 0600 UTC 8 September. Even though large-scale conditions appeared conducive for strengthening, there was a lack of a well-defined inner core. This was evidenced by visible, infrared, and microwave imagery that showed no tightly curved banding features or a concentration of deep convection close to the center, a condition that probably prevented rapid intensification during the early stages of the tropical cyclone. Floyd slowly strengthened and became a hurricane by 1200 UTC 10 September while centered about 200 n mi east-northeast of the northern Leeward Islands.

As Floyd was nearing hurricane status, a mid-tropospheric trough in the vicinity of 60-65W longitude caused a slowing of the forward speed, and then a turn toward the northwest. The northwestward motion continued until the 11th, keeping the hurricane well to the northeast of the islands of the northeastern Caribbean. On the 11th, Floyd neared the southwest portion of the mid-Atlantic upper-tropospheric trough which was situated to the north of Puerto Rico, i.e. close to its climatological position. Historically, hurricanes have had difficulty strengthening in this area. Floyd's upper-level outflow was disrupted over the southern semicircle by the trough and an anticyclone over the eastern Caribbean. Consequently, after strengthening nearly to category three status early on the 11th, the hurricane weakened to 85 knots around 0000 UTC on the 12th. Early on the 12th, rising mid- to upper-tropospheric heights to the north of Floyd forced a turn toward the west. The westward turn also marked the beginning of a major strengthening episode (this phenomenon has also been observed with many past hurricanes, e.g. Andrew of 1992). Maximum sustained winds increased from 95 knots to 135 knots, and the central pressure fell about 40 mb from early on the 12th to early on the 13th. From 0600 to 1800 on the 13th, Floyd was at the top end of category four intensity on the Saffir/Simpson Hurricane Scale.

One potential contributor to the significant strengthening of Floyd was the presence of enhanced upper oceanic heat content along its track. Analyses from the Physical Oceanography Division of NOAA/AOML showed relatively high values of heat content just to the east of the Bahamas a day

or two before Floyd passed through the area.

Floyd was aimed at the central Bahamas until late on the 13th, when the heading became west-northwestward. The eye passed just 20 to 30 n mi northeast and north of San Salvador and Cat Islands on the night of the 13th. Floyd's eyewall passed over central and northern Eleuthera on the morning of the 14th, and after turning toward the northwest, Floyd struck Abaco island on the afternoon of the 14th. By the time the hurricane hit Abaco, it had weakened somewhat from its peak, but Floyd was still a borderline category three/four hurricane.

As a mid- to upper-tropospheric trough over the eastern United States eroded the subtropical ridge over the extreme western Atlantic, Floyd continued to turn gradually to the right. The center of the hurricane paralleled the central Florida coast, passing about 95 n mi east of Cape Canaveral around 0900 UTC 15 September. By the afternoon of the 15th, Floyd was abeam of the Florida/Georgia border and headed northward toward the Carolinas.

Although there was a fluctuation in intensity, related to an eyewall replacement event discussed in the next section, overall the intensity of Floyd diminished from the 13th to the 15th. Environmental causes for intensity change are not entirely understood, but two large-scale factors probably contributed to a gradual decline: the entrainment of drier air at low levels from the northwest, and increasing south-southwesterly vertical shear. As Floyd neared the North Carolina coast late on the 15th, its maximum winds decreased below category three status.

After turning toward the north-northeast with forward speed increasing to near 15 knots, Hurricane Floyd made landfall near Cape Fear, North Carolina at 0630 UTC 16 September as a category two hurricane with estimated maximum winds near 90 knots. Floyd was losing its eyewall structure as it made landfall. Continuing to accelerate north-northeastward, Floyd's center passed over extreme eastern North Carolina on the morning of the 16th and over the greater Norfolk, Virginia area around 1500 UTC that day. Floyd then weakened to a tropical storm and moved swiftly along the coasts of the Delmarva peninsula and New Jersey on the afternoon and early evening of the 16th, reaching Long Island by 0000 UTC 17 September. By that time, the storm's forward speed had increased to near 29 knots. The system decelerated as it moved into New England.

By late on the 16th and early on the 17th, Floyd was becoming more involved with a frontal zone that existed along the Atlantic seaboard. The system took the form of a frontal low and thus became extratropical by the

time it reached the coast of Maine at 1200 UTC 17 September. The cyclone turned toward the northeast and then east-northeast, moving over the coast of New Brunswick late on the 17th, Prince Edward Island early on the 18th and Newfoundland late on the 18th and early on the 19th. Floyd's extratropical remnant merged with a large extratropical low over the north Atlantic and was no longer a distinct entity by 1800 UTC 19 September.

b. Meteorological Statistics

Table 1 lists the best track positions and intensities at six-hourly intervals. Figure 1 is a display of this track.

Figure 2a, Figure 2b, and Figure 3 depict the best track curves of maximum one-minute average "surface" (10 meters above ground level) wind speed and minimum central sea-level pressure, respectively, as a function of time. Also plotted on Figure 2a and Figure 3 are aircraft reconnaissance and dropsonde data from the U.S. Air Force Reserves (the Hurricane Hunters) and NOAA, estimates from analyses of surface synoptic data, as well as Dvorak-technique estimates from the Tropical Analysis and Forecast Branch, TAFB, the Satellite Analysis Branch, SAB, and the U.S. Air Force Weather Agency (AFGWC in the figures) using satellite imagery. Figure 2b also shows the best track wind speed curve, but with only *in situ* data, i.e. flight level and dropsonde wind measurements. In both Figure 2a and Figure 2b the flight level winds are adjusted for elevation (90% of 700 mb wind speeds, 80% of 850 mb speeds, and 85% of 1500 ft speeds), and dropsonde wind measurements above the surface are adjusted to the 10 meter level using a mean hurricane eyewall profile determined by previous dropsonde measurements.

The peak intensity of Floyd, 135 knots, is based upon roughly 90% of the highest flight level (700 mb) winds of 149 knots at 0933 UTC 13 September. Minimum dropsonde-measured central pressure was 921 mb at 1121 UTC on that date.

Floyd is estimated to have been a 90-knot hurricane at landfall in North Carolina.

There was a 10 meter anemometer measurement of sustained winds of 83 knots at 0710 UTC with gusts to 106 knots at 0716 UTC taken by University of Oklahoma meteorology professor Josh Wurman near Topsail Beach North Carolina. There were also unofficial reports of peak wind gusts to 120 knots (at 8 stories elevation) at Wrightsville Beach and 104 knots at the Wilmington Emergency Operations Center.

Table 2 lists ship reports of tropical storm force or greater wind speeds associated with Floyd. Table 3 lists a selection of surface observations from land stations and data buoys. Floyd's eye passed over NOAA data buoy 41010, located about 105 n mi east-northeast of Cape Canaveral, around 0900 UTC 15 September. That buoy reported maximum 8-minute averaged winds of 72 knots at an anemometer height of 5 meters. At least three factors would imply a higher value for the 1-minute, 10 meter wind speed from the buoy observation: 1) going from an 8-minute to a 1-minute average; 2) going from 5 meters to 10 meters elevation; and 3) the presence of waves over 50 feet high. The best track intensity of Floyd when it passed over the buoy is near 100 knots, as indicated by dropsonde and aircraft flight level wind data. The center of the hurricane passed about 25 n mi west of the Frying Pan Shoals C-MAN station located about 30 n mi southeast of Cape Fear at 0500 UTC 16 September. This station reported winds sustained at 86 knots for a 20-minute period centered at that time, at an anemometer height of 44 meters.

On 13 September, just after Floyd reached maximum strength, there was evidence of a concentric eyewall. Figure 4 is a sequence of microwave images produced by the Naval Research Laboratory. Note that in the first image, during the deepening phase, there was a dominant inner eyewall with an eye diameter of 20 to 25 n mi. Later on, after peak intensity was reached, there was some indication of a concentric eyewall, particularly in the last image of this sequence. It is interesting to note that after this period, there was an apparent eyewall replacement, as suggested in the microwave image sequence shown in Figure 5, and in radar imagery from NOAA/WP-3D aircraft research missions (not shown). It can be seen that the inner eyewall was dissipating while Floyd was centered near Eleuthera. This corresponded to a weakening of the hurricane to near 105 knots. The outer convective ring became the new eyewall by the time Floyd was centered over Abaco, corresponding to an eye diameter near 50 n mi. Afterwards, the new eye failed to contract significantly, while Floyd re-strengthened just slightly as it reached Abaco. After the disintegration of the inner eyewall the large-scale environment, as noted in the previous section, became less favorable. Consequently, after leaving the Bahamas, Floyd never regained its former intensity and, in fact, slowly weakened.

Heavy rainfall preceded Floyd over the mid-Atlantic states due to a pre-existing frontal zone and the associated overrunning. Hence, even though the tropical cyclone was moving fairly quickly, precipitation amounts were very large. Rainfall totals as high as 15 to 20 inches were recorded in portions of eastern North Carolina and Virginia. At Wilmington, North Carolina, the storm total of 19.06 inches included a 24-hour record of 15.06

inches. Totals of 12 to 14 inches were observed in Maryland, Delaware, and New Jersey. New records were set in Philadelphia for the most amount of rain in a calendar day, 6.63 inches. In southeastern New York, rainfall totals were generally in the 4 to 7 inch range but there was a report of 13.70 inches at Brewster. Totals of nearly 11 inches were measured in portions of New England.

Storm surge values as high as 9 to 10 feet were reported along the North Carolina coast.

A number of tornadoes were sighted in eastern North Carolina. There was a confirmed tornado in Bertie County and another in Perquimans County. The latter tornado destroyed two houses and damaged three or four others. At least ten tornadoes were reported by spotters in the Newport/Morehead City County Warning area, and these apparently caused some structural damage. Four tornadoes or funnel clouds were seen in the Wilmington area, but no damage was apparent.

c. Casualty and Damage Statistics

There were 57 deaths that were directly attributable to Floyd, 56 in the United States and 1 in Grand Bahama Island. The death toll by state is as follows: North Carolina 35, Pennsylvania 6, New Jersey 6, Virginia 3, Delaware 2, New York 2, Connecticut 1, and Vermont 1. Most of these deaths were due to drowning in freshwater flooding. Floyd was the deadliest hurricane in the United States since Agnes of 1972.

In the United States, the Property Claims Services Division of the Insurance Services Office reports that insured losses due to Floyd totaled 1.325 billion dollars. Ordinarily this figure would be doubled to estimate the total damage. However, in comparison to most hurricane landfalls, in the case of Floyd there was an inordinately large amount of freshwater flood damage, which probably alters the two to one damage ratio. Total damage estimates range from 3 to over 6 billion dollars.

d. Forecast and Warning Critique

When averaged over the entire lifetime of the hurricane, the track forecasts for Floyd were excellent. Table 4 shows the average track errors for the official forecast and for a selection of objective guidance models. It can be seen that the average official forecast errors were substantially below the most recent ten-year averages. Also, on average, the official forecasts were better than all of the guidance except the UKMI model which had average track errors that were about equal to those of the official

forecasts.

Although the *overall* average official forecast errors for Floyd were extremely low, the official forecasts were just ordinary if one considers only the period when hurricane warnings were in effect for the United States. For example, the average 24-hour track forecast error for the latter period was roughly the same as the most recent ten-year average. Official track forecasts during the latter period also had a westward bias, and were somewhat slow. For example, the 36-hour official track forecasts during the period when hurricane warnings were in effect for the United States were an average of 104 n mi too far west and 70 n mi too far south. All of the track guidance models showed a similar westward and slow bias during this period.

Official intensity forecasts were fairly good (errors of 10 knots or less) for the first couple of days of Floyd's history. However, there were some large underforecasts of intensity, by as much as 30 to 40 knots, from 10-12 September. After Floyd reached its maximum intensity, the official forecasts did not show enough weakening. From 13 September onward, the wind speed was overpredicted in the advisories at practically every forecast time interval, by as much as 30 to 40 knots, and even 50 knots in one occasion. The Statistical Hurricane Intensity Prediction Scheme, SHIPS, performed similarly.

Table 5 is a chronology of the various watches and warnings that were issued for Floyd. A hurricane warning was issued for the northwest Bahamas more than 24 hours prior to the arrival of the eyewall at Eleuthera. For the United States, practically the entire east coast (the greater Miami area northward to Plymouth Massachusetts) was put under a hurricane warning for Floyd. To the authors' knowledge, the last time such an event occurred was during Hurricane Donna of 1960. Hurricane warnings for the southeast Florida coast proved unnecessary. However, given the forecast uncertainty and the required response times for evacuations and other preparations for such a large, severe hurricane, it was prudent to issue such warnings. The hurricane warning was issued for the coast of North Carolina at 0300 UTC 15 September. This is about 26-27 hours prior to the arrival of the eyewall in the Cape Fear area. Generally, for the coasts of South and North Carolina, hurricane warnings were issued at least 24 hours before the onset of tropical storm force winds.

According to preliminary information provided to the Federal Emergency Management agency, over 2 million people were evacuated for Floyd in the United States. This is probably the largest evacuation in U.S. history.

Acknowledgements

Some of the data in this report was furnished by local National Weather Service Offices in Miami, Melbourne, Jacksonville, Charleston, Wilmington, Newport/Morehead City, Raleigh/Durham, Wakefield, Baltimore/Washington, Mount Holly, New York, and Taunton. Stephen Baig produced the track chart, and James Franklin produced the wind and pressure plots.

Figure 1. Best track for Hurricane Floyd, 7-17 September 1999.

Figure 2a. Best track maximum sustained wind speed curve for Hurricane Floyd, showing all available intensity estimates and wind observations. Aircraft wind measurements have been adjusted for elevation (90% of 700 mb wind speeds, 80% of 850 mb speeds, and 85% of 1500 ft speeds), and dropsonde wind measurements above the surface are adjusted to the 10 meter level using a mean hurricane eyewall profile determined by previous dropsonde measurements. Vertical line denotes landfall.

Figure 2b. Best track maximum sustained wind speed curve for Hurricane Floyd, showing only in situ wind observations adjusted for elevation as indicated in Figure 2a.

Figure 3. Best track minimum central pressure curve and central pressure observations or estimates for Hurricane Floyd. Vertical line denotes landfall.

Figure 4. Sequence of microwave images of Hurricane Floyd at: (a) 0116 UTC, (b) 1122 UTC, (c) 1347 UTC, and (d) 2240 UTC 13 September, 1999.

Figure 5. Sequence of microwave images of Hurricane Floyd at: (a) 2240 UTC 13 September, (b) 0104 UTC, (c) 1110 UTC, and (d) 2228 UTC 14 September, 1999.

Table 1. Best track, Hurricane Floyd, 7 - 17 September, 1999

Date/Time (UTC)	Position		Pressure (mb)	Wind Speed (kt)	Stage
	Lat. (°N)	Lon. (°W)			
7/1800	14.6	45.6	1008	25	tropical depression
8/0000	15.0	46.9	1007	30	"
0600	15.3	48.2	1005	35	tropical storm
1200	15.8	49.6	1003	40	"
1800	16.3	51.1	1000	45	"
9/0000	16.7	52.6	1000	45	"
0600	17.1	53.9	1003	45	"
1200	17.3	55.1	1003	50	"
1800	17.9	56.3	996	60	"

10/0000	18.3	57.2	995	60	"
0600	18.6	58.2	990	60	"
1200	19.3	58.8	989	70	hurricane
1800	20.2	59.6	975	70	"
11/0000	20.8	60.4	971	80	"
0600	21.4	61.1	963	95	"
1200	21.9	62.0	962	95	"
1800	22.5	63.0	966	90	"
12/0000	22.7	64.1	967	85	"
0600	22.8	65.2	960	95	"
1200	23.0	66.2	955	105	"
1800	23.2	67.4	940	115	"
13/0000	23.4	68.7	931	125	"
0600	23.6	70.0	922	135	"
1200	23.9	71.4	921	135	"
1800	24.1	72.9	923	125	"
14/0000	24.5	74.0	924	115	"
0600	24.9	75.3	927	105	"
1200	25.4	76.3	930	105	"
1800	26.1	77.0	930	110	"
15/0000	27.1	77.7	933	115	"
0600	28.2	78.5	935	110	"
1200	29.3	78.9	943	100	"
1800	30.6	79.1	947	95	"
16/0000	32.1	78.7	950	90	"
0600	33.7	78.0	956	90	"
1200	35.7	76.8	967	70	"
1800	38.0	75.3	974	60	tropical storm
17/0000	40.6	73.5	980	50	"
17/0600	42.1	72.1	983	50	tropical storm
1200	43.3	70.6	984	45	extratropical
1800	44.2	68.9	985	45	"
18/0000	44.8	67.3	987	40	"
0600	45.4	65.5	990	35	"
1200	46.6	63.0	992	35	"
1800	47.7	59.3	992	35	"
19/0000	48.0	56.3	992	35	"

0600	48.5	52.5	994	35	"
1200	49.5	48.0	992	40	"
1800					merged with low
13/1200	23.9	71.4	921	135	minimum pressure
					Landfalls
14/1200	25.4	76.3	930	105	Near Alice Town, Eleuthera
14/1900	26.3	77.1	932	120	Near Cherokee Sound, Abaco
16/0630	33.8	78.0	956	90	Near Cape Fear, North Carolina

Table 2. Ship reports of 34 knots or higher wind speed associated with Hurricane Floyd, September 1999.

Date/Time (UTC)	Ship call sign	Lat. (°N)	Lon. (°W)	Wind dir/speed (deg/kt)	Pressure (mb)
08/1500	PDYI	19.0	52.6	070/39	1011.1
09/0900	DFSO	17.2	53.7	180/37	1004.2
09/1200	DFSO	16.9	54.5	210/37	1005.2
09/1500	DFSO	16.6	55.4	180/45	1005.5
12/1500	DGOO	22.7	69.3	320/35	1001.5
12/1800	DGOO	23.5	69.5	340/37	998.5
12/1800	ZCAH3	24.9	63.1	130/58	1009.3
12/2100	DGOO	24.1	69.8	030/43	994.8
13/0000	DGOO	24.5	69.9	040/45	994.8
13/0300	DGOO	24.9	70.3	040/52	997.0
13/0600	DGOO	25.6	70.5	040/52	998.5
13/0900	DGOO	26.3	70.8	060/52	999.5
13/1200	DILD	24.9	53.1	170/37	1013.9
13/1200	DGOO	27.0	71.0	090/52	1002.9
13/1800	KHRH	19.5	74.7	360/50	994.0
13/1800	WZJF	21.3	66.9	135/35	1009.5
14/0000	PPXI	30.6	74.3	070/50	1001.0
14/0900	WGJT	22.0	73.5	180/35	998.2
14/1200	PPXI	30.4	71.0	110/45	1001.0
14/1500	PEXU	26.7	70.6	120/37	1009.2

15/0300	SHIP	30.3	74.3	100/45	1006.5
15/0900	DGOS	29.3	73.8	130/38	1004.0
15/1200	DGOS	28.9	73.8	130/47	1003.5
15/1200	PFKV	30.6	74.0	120/38	1004.4
15/1800	PFKV	30.3	74.0	130/36	1003.6
16/0000	WRGQ	31.5	75.4	160/46	(898.1)
16/0300	PEXU	29.4	73.9	190/36	1008.5
16/0600	WRGQ	31.2	75.2	200/41	1001.0
16/0600	SHIP	36.8	73.0	140/36	1006.8
16/1200	WZJE	32.0	71.6	180/38	1008.5
16/1200	3ELL6	32.0	72.5	200/36	1007.2
16/1800	BKJO	34.7	72.2	190/60	1005.0
16/1800	WZJE	32.1	72.3	210/52	1009.6
16/2100	DEDI	40.4	70.9	130/42	998.0
16/2100	SHIP	36.6	69.5	180/47	1007.0
17/0000	DEDI	40.4	70.8	140/50	993.3
17/0000	SHIP	36.6	68.4	190/40	1009.5
17/0000	WAUU	36.0	68.5	190/46	1009.7

Table 3. Hurricane Floyd, selected surface observations, September 1999.

	Minimum sea-level pressure		Maximum surface wind speed (kt)					
Location	Press. (mb)	Date/ time (UTC)	Sust. wind ^a (kts)	Peak gust (kts)	Date/ time ^b (UTC)	Storm surge ^c (ft)	Storm tide ^d (ft)	Rain (storm total) (in)
Bahamas								
Grand Bahama Island	983.0	15/0100	52	65	14/2000		5.27	
Little Harbor Abacos	929.0	14/1910						9.32
Nassau			55	68				
Florida								
Craig Field	994.6	15/1653	37		15/1929			
Daytona Beach	991.8	15/1353	36	60	15/1053			1.23
Fowey Rocks Lighthouse	995.5	14/2300	36	44	14/1600			
Ft. Lauderdale Exec	994.9	14/2253	23	33	15/0653			0.01

Ft. Lauderdale Int'l	994.6	14/2253	25	36	14/2201			0.10
Ft. Pierce	989.5	15/0735	29	43	15/0736			
Gainesville	994.6	15/1653	33		15/1407			
Jacksonville Int'l	995.3	15/1656	40		15/0907			
Lake Worth Pier	993.4	14/2200	32	49	14/1700			
Leesburg	996.4	15/1053	20	27	15/1153			
Melbourne Airport	989.1	15/0900	45	59	15/0501			1.35
Melbourne WFO			32	52	15/0655			
Miami	995.8	14/2256	19	29	15/0322			0.04
Ocala	998.0	15/1035	28		15/1535			
Orlando	993.8	15/0853	24	42	15/0853			1.26
Patrick AFB (COF)			49	57	15/0820			
Sanford			25	37	14/2024			3.20
Tamiami Airport	996.4	14/2253	21	31	14/1953			
West Palm Beach	992.9	15/0453	27	38	14/1941			0.38
Georgia								
Alma	999.7	15/950	28		15/1746			
Brooklet								0.41
Dover								0.40
Ludowici								0.52
Newington								0.85
Rocky Ford								0.20
Savannah Airport			35	46	15/1810			
St. Simon's Island	993.2	15/1804	40		15/1804			
South Carolina								
Allendale								0.67
Beaufort								1.83
Charleston City Office			50	74	16/0150			3.99
Charleston Harbor							10.1	
Charleston Int'l Airport	989.5	15/0052	44	58	16/0046			3.91
Edisto Beach State Park			33	47	16/0029			
Florence Airport	991.2	16/0655	36	54	16/0158			4.04
Folly Beach			47	62	15/2300			
Grand Strand	977.0	16/0553		57	16/0523			
Ladson Oakbrook								4.30

Myrtle Beach Airport	979.7	16/0553		62	16/0455			16.06
Myrtle Beach Springmaid Pier				68	16/0500			
Ridgeville								3.58
St. George								1.90
Walterboro								2.50
Williams								2.42
North Carolina								
Beaufort	976.0	16/0409	42	58	16/0405			5.56
Castle Hayne 2E				81	16/0715			
Castle Hayne 3SW				104	16/0845			
Cherry Point MCAS	961.4	16/0555	56	71	16/0405			3.27
Elizabeth City	968.5	16/1418	34	56	16/1346			2.65
Federal Point				97	16/0620			
Flemington				80	16/0625			
Frisco	983.8	16/0740	51	61	16/0805			0.34
Greenville				51	16/0800			
Holden Beach			42	64	16/0820			
Manteo				53	16/1000			
Masonboro Island							10.3	
Mt. Olive				65	16/0520			
Myrtle Grove				89	16/0540			
Newport				58	16/0454			
New Bern	961.1	16/0543	39	58	16/0501			4.29
New River	959.0	16/0426	44	68	16/0556			8.26
Oak Island			52	69	16/0820		10.0	
Pleasure Island							10.0	
Rocky Mount/Wilson Airport								15.15
Seymour Johnson AFB	983.0	16/0955	45	60	16/1055			
South River								3.50*
Washington				41	16/0800			
Wilmington Airport	959.7	16/0755	54	75	16/0855			19.06
Wilmington Corning Plant				89	16/0700			
Wilmington EOC				104	16/0845			
Wrightsville Beach				120				
Virginia								

Fort Eustis	985.2	16/1455	25	37	16/1640			
Gloucester								11.25
Hampton								7.50
James City County								14.30
Langley AFB			40	55	16/1355			
Lower James City								12.83
Newport News	983.4	16/1558	33	44	16/1623			16.57
Norfolk Airport	977.1	16/1551	27	40	16/1303			
Norfolk NAS	979.1	16/1555	38	48	16/1609			
Oceana NAS	975.7	16/1556	35		16/1656			
Portsmouth	978.3	16/1600	30	52	16/1614			10.10
Richmond	991.9	16/1640	29	44	16/1405			6.54
Smithfield								12.50
Wakefield WFO								12.73
Weems								10.83
Yorktown								
Maryland								
Annapolis								11.60
Cambridge							2.5	
Chestertown								14.00
Lewisetta							3.5	
Martin State Airport	989.0							
Mid-Bay Buoy				60	16/1710			
Ocean City	976.8	16/1853	31	45	16/1653			1.71
Patuxent NAS	991.0		30	36	16/1555			
Salisbury	980.4	16/1851	28	42	16/2150			5.08
Solomon's Island							3.0	
St. Inigoes	987.6							
Tall Timbers				62	16/2040			11.10
Thomas Point Light			43	49	16/1300			
Delaware								
Cape Henlopen				56	16/PM			
Greenwood								10.58
Lewes						2.6	6.76	
Vernon								12.36
Wilmington	986.0	16/2106	32	40	16/2214			
New Jersey								
American Corners								10.20

Atlantic City	980.2	16/2054	23	34	16/2345	2.0	6.22	
Caldwell/Essex Co. Airport	987.8	16/2353		38	16/2353			10.21
Cape May						2.6	7.36	
Doylestown								10.07
Federalsburg								11.20
Neshanic								10.07
Newark Int'l Airport	985.1	16/2351	38	46	16/2351			6.22
Pequannock								11.04
Sandy Hook	981.0	16/2306	34	45	17/0024	1.9	6.57	
Somerville								13.34
Teterboro Airport	985.0	16/2351	24	38	16/2351			8.53
Wayne/Iflows								12.21
White House								12.98
Pennsylvania								
Philadelphia	985.0	16/2136	32	42	16/2136	2.8	9.34	
New York								
Central Park	983.8	16/2250	25	36	16/1450			5.02
Farmingdale Airport	981.6	16/2353	23	37	16/2053			3.13
HPN Airport	985.8	17/0050	25	42	16/2350			6.26
Islip/MacArthur Airport	983.4	17/0156	27	37	16/2356			
JFK Int'l Airport	982.5	16/2351	30	41	17/0051			3.27
LaGuardia Airport	983.7	16/2351	30	41	17/0051			4.94
MGJ Airport			29	44	16/2039			
MTP Airport	986.9	17/0254	22	37	17/0454			
Newburgh/Stewart Airport	992.6	17/0045	34	54	16/2245			
NWS Upton								3.50
Westhampton Airport	984.8	17/0153	28	43	17/0153			
White Plains Airport	985.8	17/0050	25	42	16/2350			
Massachusetts								
Beverly				31				
Blue Hill Observatory-Milton				40				
Boston							10.7	
Boston/Logan Airport				38				
Brewster				63	17/0545			
Buzzards Bay			47	57	17/0300			

Fox Point Hurricane Barrier						4.2		
Hadley								9.60
Hyannis				62				
Lawrence				32				
Martha's Vineyard				34				
Nantucket				32			1.3	
New Bedford Hurr. Barrier				64	17/0600	2.5		
Norwood				27				
Orange				29				
Plymouth				33				
Southwick								9.16
Taunton				38				
Westfield				37				
Worcester				30				
Rhode Island								
Block Island				39				
Newport				35			2.6	
Providence				35			5.9	
Westerly				31				
Connecticut								
Bridgeport Airport	981.8	17/0154	29	39	16/2254			
Bristol								10.80
Burlington								9.45
Danbury Airport	987.1	17/0153	15	21	17/0153			
Groton/New London Airport	986.8	17/0145	30	43	17/0045			
Hartford Airport	985.4	17/0253						
Meriden	984.5	17/0156						
MMK Airport	986.4	17/0155	20	34	17/0155			
New Haven Airport	983.8	17/0145	33					
Southington								9.14
Willimantic	985.8	17/0352		31				
Windsor Locks				37				
New Hampshire								
Manchester				28				
NOAA National Data Buoy Center buoys								

41004 (30.5N 79.1W)			54	72	16/0200			
41009 (28.5N 80.2W)	980.9	15/0900	52	70	15/1000			
41008 (31.4N 80.9W)			24	31	15/2100			
41010 (28.9N 78.5W)	939.6	15/0900	72	91	15/0700			
44009 (38.5N 74.7W)	976.0	16/1900	39	52	16/1800			
44014 (36.8N 74.8W)	981.4	16/1600	50	66	16/1615			
44025 (40.3N 73.2W)	980.0	17/0000	33	43	17/0600			

NOAA National Data Buoy Center C-MAN stations

BUZM3 (41.4N 71.0W)			47	57	17/0300			
CLKN7 (34.6N 76.5W)	974.9	16/0500	63	79	16/0450			
DSL7 (31.2N 75.3W)	985.8	16/0730	69	82	16/0750			
DUCN7 (36.2N 75.8W)	977.0	16/0900	67	83	16/0850			
FPSN7 (33.5N 77.6W)	958.7	16/0600	86	97	16/0512			
SAUF1 (29.9N 81.3W)	992.9	15/1200	58		15/1200			

^aASOS and C-MAN are 2 min; buoys are 8 min.

^bDate/time is for sustained wind when both sustained and gust are listed.

^cStorm surge is water height above normal astronomical tide level.

^dStorm tide is water height above National Geodetic Vertical Datum (1929 mean sea level).

Table 4. Preliminary forecast evaluation of Hurricane Floyd, heterogeneous sample. (Errors in nautical miles for tropical storm and hurricane stages with number of forecasts in parenthesis).

Forecast Technique	Period (hours)				
	12	24	36	48	72
CLIP	40 (35)	88 (33)	148 (31)	206 (29)	312 (25)
GFDI	36 (34)	71 (32)	97 (30)	115 (28)	153 (25)
GFDL*	31 (30)	66 (30)	96 (28)	109 (26)	155 (24)
LBAR	30 (34)	59 (32)	92 (30)	112 (28)	120 (24)
AVNI	38 (35)	77 (33)	119 (31)	141 (29)	187 (25)
BAMD	37 (34)	70 (32)	106 (30)	147 (28)	239 (24)
BAMM	50 (34)	96 (32)	137 (30)	175 (28)	243 (24)

BAMS	63 (34)	123 (32)	173 (30)	207 (28)	263 (24)
A98E	35 (33)	72 (31)	113 (29)	120 (27)	174 (24)
NGPI	39 (29)	69 (27)	101 (25)	123 (23)	146 (19)
UKMI	29 (32)	54 (30)	66 (26)	76 (24)	97 (21)
NHC OFFICIAL	28 (35)	53 (33)	73 (31)	73 (29)	104 (25)
NHC OFFICIAL 1989-1998 10-year average	48 (2005)	89 (1790)	128 (1595)	164 (1410)	242 (1107)

* GFDL output not available until after forecast issuance.

Table 5. Watch and warning summary, Hurricane Floyd, September 1999

Date/Time (UTC)	Action	Location
09/2100	Tropical storm watch issued	Antigua, Barbuda, Anguilla, and Dutch Saint Maarten
09/2200	Tropical storm watch issued	French Saint Martin and Saint Barthelemy
11/0300	Tropical storm watch discontinued	Antigua, Barbuda, Anguilla and Dutch Saint Maarten
11/0300	Tropical storm watch discontinued	French Saint Martin and Saint Barthelemy
12/0900	Tropical Storm warning and hurricane watch issued	Turks, Caicos, and Southeast Bahamas
12/0900	Hurricane watch issued	Central Bahamas
13/0000	Hurricane warning issued	Central Bahamas
13/0000	Hurricane watch issued	Northwest Bahamas
13/0900	Hurricane watch upgraded to hurricane warning	Northwest Bahamas
13/0900	Hurricane watch issued	Florida: South of Flagler Beach to Hallandale
13/1500	Hurricane watch extended	South to include Miami-Dade County and north of Flagler Beach, Florida to Brunswick, Georgia
13/1800	Hurricane watch extended	Including Lake Okeechobee
13/2100	Hurricane watch upgraded to hurricane warning	Florida City, Florida to south of Brunswick, Georgia

13/2100	Tropical storm warning issued	Florida Keys, north of Seven Mile Bridge
13/2100	Hurricane watch issued	Georgia: Brunswick to Savannah
14/0300	Hurricane watch extended	North of Savannah, Georgia to Little River Inlet, South Carolina
14/0900	Tropical storm warning discontinued	Turks and Caicos Islands
14/1500	Tropical storm warning discontinued	Southeast Bahamas
14/2100	Tropical storm warning discontinued	Florida Keys, from the Seven Mile Bridge northward
14/2100	Hurricane warning extended	Georgia and South Carolina coasts to Little River Inlet, South Carolina
14/2100	Hurricane warning downgraded to tropical storm warning	Florida: Florida City to Boca Raton
14/2100	Hurricane watch extended	North of Little River Inlet, South Carolina to Cape Charles Light, Virginia, south of New Point Comfort, including Pamlico and Albermarle sounds
15/0300	Hurricane warning extended	North of Little River Inlet, South Carolina to the North Carolina/Virginia border
15/0300	Hurricane warning discontinued	Florida: Boca Raton to Ft. Pierce
15/0300	Hurricane watch extended	North Carolina/Virginia border to Chincoteague, Virginia, including Chesapeake Bay, south of Smith Point
15/0300	Hurricane warning discontinued	Central Bahamas
15/0300	Tropical storm warning discontinued	Florida: Florida City to Ft. Pierce
15/0600	Hurricane warning discontinued	Northwest Bahamas: New Providence, Bimini, Andros, and Berry Islands
15/0900	Tropical storm watch issued	Chincoteague, Virginia to Cape Henlopen, Delaware, including Chesapeake Bay north of Smith Point and the Potomac from Cobb Island to Smith Point
15/1200	Hurricane warning discontinued	Florida: South of Sebastian Inlet to Ft. Pierce Northwest Bahamas: Grand Bahama and Abaco Islands
15/1500	Hurricane warning discontinued	Florida: Sebastian Inlet to Titusville
15/1500	Tropical storm watch extended	North of Chincoteague, Virginia to Sandy Hook, New Jersey, including Delaware Bay
15/1700	Tropical storm watch	North of Sandy Hook, New Jersey to Montauk Point

15/1700	extended	on Long Island, New York, including Delaware Bay
15/1900	Hurricane warning discontinued	Florida: Titusville to Fernandina Beach
15/2100	Hurricane warning extended	North of North Carolina/Virginia border to Chincoteague, Virginia, including Chesapeake Bay, south of Smith Point
15/2100	Tropical storm watch upgraded to tropical storm warning	North of Chincoteague, Virginia to Sandy Hook, New Jersey, including northern Chesapeake Bay, the Potomac Basin, and Delaware Bay
15/2100	Tropical storm watch extended	North of Sandy Hook, New Jersey to the Merrimack River, Massachusetts, including Long Island Sound
16/0300	Hurricane warning discontinued	North of Fernandina Beach, Florida to Edisto Beach, South Carolina
16/0300	Hurricane warning extended	North of Chincoteague, Virginia to Cape Henlopen, Delaware
16/0300	Tropical storm warning extended	North of Sandy Hook, New Jersey to Plymouth, Massachusetts
16/0900	Hurricane warning extended	North of Cape Henlopen, Delaware to Manasquan Inlet, New Jersey and from Moriches Inlet, New York to Plymouth, Massachusetts
16/0900	Tropical storm warning extended	North of Plymouth, Massachusetts to Merrimack River, Massachusetts
16/1100	Hurricane warning discontinued	From South Santee River, South Carolina, southward
16/1300	Hurricane warning discontinued	South Santee River, South Carolina to Surf City, North Carolina
16/1500	Hurricane warning discontinued	North Carolina: North of Surf City to Cape Hatteras
16/1800	Hurricane warning discontinued	Cape Hatteras, North Carolina to Cape Charles Light, Virginia, including southern Chesapeake Bay
16/2100	Hurricane warning downgraded to tropical storm warning	Cape Charles Light, Virginia to the Merrimack River, Massachusetts, including Chesapeake Bay, the Potomac Basin, Delaware Bay, and Long Island Sound
17/0300	Tropical storm warning discontinued	Cape Charles Light, Virginia to Sandy Hook, New Jersey, including Chesapeake Bay, the Potomac Basin, and Delaware Bay
17/0900	Tropical storm warning discontinued	Sandy Hook, New Jersey to the Merrimack River, Massachusetts, including Long Island Sound

Todd Spindler

Last updated January 26, 2000

Appendix C

Hurricane Behavioral Floyd Response Questionnaire

**Hurricane Floyd
Response Questionnaire**

Hello, my name is _____ and I'm calling on behalf of the Army Corps of Engineers and your state emergency management office. I'm conducting a telephone survey of residents concerning experiences in hurricane Floyd last summer, so that we can improve hurricane evacuation plans for the future. May I please speak with the **(ROTATE)**:

1. Youngest male over 18
2. Oldest male
3. Youngest female over 18
4. Oldest female in your household?

My questions will only take a few minutes. Your responses are important to us so that we may have accurate information about hurricane preparedness. Before we begin, let me assure you everything you say will remain strictly confidential.

1. Do you live at this residence year-round?

1 Yes (**GO TO Q3**)
2 No (**GO TO Q2**)
3 Other (**GO TO Q2**)

2. Do you live here at least part of the time during the summer or fall?

1 Yes (**GO TO Q3**)
2 No (**THANK & TERMINATE**)
3 Other (**THANK & TERMINATE**)

IF "NO," TERMINATE THE INTERVIEW BY RESPONDING "THANK YOU FOR YOUR TIME, BUT WE ARE LOOKING FOR PEOPLE WHO ARE IN THIS REGION DURING THAT TIME FRAME. THANK YOU AGAIN. GOODBYE."

3. Were you in the area, i.e., not out of town, when **HURRICANE FLOYD** began to threaten your area last September?

1 Yes (**GO TO Q4**)
2 No (**THANK AND TERMINATE**)
3 Other (**THANK AND TERMINATE**)

IF "NO," TERMINATE THE INTERVIEW BY RESPONDING "THANK YOU FOR YOUR TIME, BUT WE ARE LOOKING FOR PEOPLE WHO WERE IN THIS AREA AT THAT TIME. THANK YOU AGAIN. GOODBYE."

4. Did you leave your home to go someplace safer in response to the threat created by Hurricane Floyd?

1 Yes (**GO TO Q6**)
2 No (**GO TO Q5**)
3 Other, _____ (**GO TO Q44**)
9 Don't know (**GO TO Q44**)

5. What made you decide *not* to go anyplace else? (**CATEGORIZE - PROBE UP TO 3**) (**THEN GO TO Q44**)

a 0/1 Storm not severe/house adequate
b 0/1 Officials said evacuation unnecessary
c 0/1 Media said evacuation unnecessary
d 0/1 Friend/relative said evacuation unnecessary
e 0/1 Officials didn't say to evacuate
f 0/1 Probabilities indicated low chance of a hit
g 0/1 Other information indicated storm wouldn't hit
h 0/1 Had no transportation
i 0/1 Had no place to go
j 0/1 Wanted to protect property from looters
k 0/1 Wanted to protect property from storm
l 0/1 Left unnecessarily in past storms
m 0/1 Job required staying
n 0/1 Waited too long to leave
o 0/1 Traffic too bad
p 0/1 Tried to leave, but returned home because of traffic
q 0/1 Too dangerous to evacuate because might get caught on road in storm
r 0/1 No place to take pets/Shelter would not accept pets
s 0/1 Required special medical care
t 0/1 Other, specify: _____
u 0/1 Don't know

5v. IF Floyd had looked to you like it was going to hit this area more directly, would you have left your home to go someplace safer?

- 1 Yes
2 No
3 Don't Know/Depends
4 Other (Specify) _____

5w. Were you ready, that is had you made the necessary preparations, to leave your home to go someplace safer in the event the situation had worsened?

- 1 Yes
2 No
3 Don't Know/Depends
4 Other (Specify) _____

5x. Would you or anyone in your household require assistance in evacuating?

- 1 Yes
2 No (SKIP TO Q 44)
3 Not sure (SKIP TO Q 44)

5y. Would the person just need transportation, or do they have a disability or medical problem that would require special assistance?

- 1 Transportation only
2 Special need (disability or medical problem)
3 Both
4 Other, specify: _____
5 Don't know

5z. Would that assistance provided by someone within your household, or by an outside agency, or by a friend or relative outside your household?

- 1 Within household
2 Friend/relative (outside)
3 Outside agency
4 Other, _____
9 Don't know

(IF ANSWERING Q5z, SKIP TO Q44)

6. What convinced you to go leave your home to go someplace safer? (CATEGORIZE - PROBE UP TO 3)

- a 0/1 Advice or order by elected officials
b 0/1 Advice from Weather Service
c 0/1 Advice/order from police officer or fire fighter
d 0/1 Advice from media
e 0/1 Advice from friend or relative
f 0/1 Concerned about severity of storm
g 0/1 Storm as strong as/stronger than/bigger than Andrew/Hugo
h 0/1 Storm increased in strength
i 0/1 Concerned storm would cause home to flood
k 0/1 Concerned strong winds would make house unsafe
l 0/1 Concerned flooding would cut off roads
m 0/1 Concern that storm might hit
n 0/1 Heard probability (odds) of hit
o 0/1 Wanted to avoid conditions after the storm (no electricity, etc.)
p 0/1 Other, specify: _____
q 0/1 Don't know

7. Which of the following would you say had the GREATEST influence on your decision to go leave your home to go someplace safer? (READ - RECORD ALL MENTIONED)

- a 0/1 Information from government officials
b 0/1 Information from the media, NOT COUNTING THE MEDIA'S COVERAGE OF WHAT GOVERNMENT OFFICIALS WERE SAYING
c 0/1 Information from friends/relatives
d 0/1 Other factors
e 0/1 Other, _____
f 0/1 Don't know

8a. **FOR DADE/BROWARD, FLORIDA:**

The National Hurricane Center issued a Hurricane Watch for this area at 5 AM on the morning of Monday, September 13th for Broward and 11 AM for Dade. That was followed by a Hurricane Warning later that same day at 5 PM. On what day did you leave your home to go someplace safer?

- 1 Sunday, September 12th or earlier
- 2 Monday, September 13th
- 3 Tuesday, September 14th
- 4 Wednesday, September 15th
- 5 Thursday, September 16th
- 6 Other _____
- 9 Don't know

8b. About what time on the **(REPEAT DATE)** did you leave? **(USE 1 HOUR INCREMENTS)**
(TAKE MIDPOINT) (99=DK)
 _____ Hour **(IF 99, SKIP TO Q13)**

8c. Was that morning AM or PM? **(NOTE: 12 O'CLOCK NOON = 12 PM)**
(NOTE: 12 O'CLOCK MIDNIGHT = 12 AM ON THE "NEW" DAY)

- 1 AM (morning / or midnight until noon)
- 2 PM (afternoon/evening or noon until midnight)

9. Did you go to a public shelter, a friend or relative's house, a hotel, or somewhere else? **(DO NOT READ)**

- 1 Public shelter (Red Cross) **(GO TO Q. 10)**
- 2 Church **(SKIP TO Q. 12)**
- 3 Friend/relative **(SKIP TO Q. 12)**
- 4 Hotel **(SKIP TO Q.12)**
- 5 Workplace **(SKIP TO Q.12)**
- 6 Mobile home park clubhouse **(SKIP TO Q. 12)**
- 7 Other, specify: **(SKIP TO Q. 12)**
- 9 Don't know **(SKIP TO Q. 12)**

10. Why did you go to a public shelter rather than going someplace else? **(CATEGORIZE – PROBE UP TO 3)**

- 0/1 Close to home
- 0/1 Safer than home/ther places
- 0/1 Not enough time to get to anyplace else
- 0/1 Couldn't find motel with vacancy
- 0/1 Got tired of driving
- 0/1 Couldn't afford hotel/motel
- 0/1 Had no place else to go
- 0/1 Officials recommended going to public shelter
- 0/1 Media recommended going to public shelter
- 0/1 Friend/relative recommended going to public shelter
- 0/1 Other, specify: _____
- 0/1 Don't Know

11. Do you have a friend or relative in your own county who lives in a well-built home in a safe location that you could have stayed with when you evacuated instead of going to a public shelter?

- 1 Yes
- 2 No
- 9 Don't know

12. Is that **(ANSWER FROM #9)** located in your neighborhood or someplace else?

- 1 Neighborhood **(SKIP TO Q18)**
- 2 Somewhere else
- 9 Don't know

13. In which city is that located?

14. Is that **(ANSWER FROM #13)** located in your county?

- 1 Yes **(SKIP TO Q18)**
- 2 No
- 9 Don't know

15. In which state is that located?

- 1 Florida
- 2 Georgia
- 3 South Carolina
- 4 North Carolina
- 5 Alabama
- 6 Tennessee
- 7 Virginia
- 8 Other, _____
- 9 Don't know

16. Why did you go so far – that is, to a destination outside your own county? (**CATEGORIZE - PROBE UP TO 3**)

- a 0/1 Storm strong; needed to go that far to be safe
- b 0/1 Previous hurricane experience (e.g., Andrew/Hugo)
- c 0/1 Government officials comparison to Andrew/Hugo
- d 0/1 Media officials comparison to Andrew/Hugo
- e 0/1 Officials, emergency management said to leave county
- f 0/1 Media said to leave county
- g 0/1 Friend/relative said to leave county
- h 0/1 Friend/relative lives (lived) there
- i 0/1 No public shelters available closer
- j 0/1 No motels available closer
- k 0/1 Other, _____
- l 0/1 Don't know

17. Which of the following would you say had the GREATEST influence on your decision to go someplace outside your own county? (**READ – RECORD ALL MENTIONED**)

- a 0/1 Information from government officials
- b 0/1 Information from the media, **NOT COUNTING THE MEDIA'S COVERAGE OF WHAT GOVERNMENT OFFICIALS WERE SAYING**
- c 0/1 Information from friends/relatives
- d 0/1 Other factors
- e 0/1 Other, _____
- f 0/1 Don't know

18. Was that your original destination when you set out to evacuate, or did you change your mind about where to go after leaving home?

- 1 Changed destination (**GO TO Q19**)
- 2 Reached original destination (**SKIP TO Q121**)
- 9 Don't Know (**SKIP TO Q21**)

19. Did you end up going farther from home than you had planned or not as far?

- 1 Farther
- 2 Not as far
- 3 About the same distance
- 9 Don't Know

20. What caused you to change your mind about where to go? (**CATEGORIZE; PROBE UP TO 3**)

- a 0/1 Traffic congestion
- b 0/1 Information about better routes
- c 0/1 Information about available shelter or lodging
- d 0/1 Running out of gasoline
- e 0/1 Tired of being on road
- f 0/1 Hungry
- g 0/1 Needed to use bathroom
- h 0/1 Storm getting too close to continue
- i 0/1 Storm got stronger
- j 0/1 Other; specify: _____
- k 0/1 Don't know

21. Before you left your home, did you hear any announcements about traffic problems on routes you planned to use?

- 1 Yes (**GO TO Q22**)
- 2 No (**SKIP TO Q23**)
- 9 Don't Know (**SKIP TO Q23**)

22. Did you change your plans as to which routes to use after hearing that?
1 Yes
2 No
9 Don't Know
23. After you left your home and were on the road, did you hear any announcements about traffic problems on routes you were using or planned to use?
1 Yes (GO TO Q24)
2 No (GO TO Q25)
9 Don't Know (GO TO Q25)
24. Did you change your plans as to which routes to use after hearing that?
1 Yes
2 No
9 Don't Know
25. Did you use interstate highways for a significant part of your travel after you got out of town?
1 Yes (GO TO Q26)
2 No (GO TO Q27)
9 Don't Know (GO TO Q27)
26. Would you use the interstate highways again in future evacuations, or would you be more likely to use secondary highways?
1 Interstate
2 Secondary
3 Both
4 Depends on congestion
5 Depends on other factors
6 Other, _____
9 Don't Know
27. Were you familiar enough with the roads in the area where you were traveling so that you could change to a different route if you wanted to?
1 Yes
2 No
9 Don't Know
28. Suppose that government officials urged you to use a different route than you would normally use, in order to avoid congestion. Would you be willing to use a route recommended by officials, even if it took you out of your way before getting you to your destination?
1 Yes
2 No
3 Depends
4 Other, _____
9 Don't Know
29. After you left your home and were on the road, did you hear any announcements about places you could seek shelter in case you couldn't reach your destination?
1 Yes (GO TO Q30)
2 No (GO TO Q31)
9 Don't Know (GO TO Q31)
30. Did you change your plans about where to seek shelter after hearing that?
1 Yes
2 No
9 Don't Know
31. How long did it take you to get to where you were going? (WAS IT MORE OR LESS THAN 2 HOURS?) (USE 1 HOUR INCREMENTS) (TAKE MIDPOINT) (88.8=NEVER GOT THERE) (99.9=DK) (ROUND TO NEAREST ½ HOUR)
_____ Hours
32. How long did you EXPECT it take you to get to where you were going? (WAS IT MORE OR LESS THAN 2 HOURS?) (USE 1 HOUR INCREMENTS) (TAKE MIDPOINT) (99.9=DK) (ROUND TO NEAREST ½ HOUR)
_____ Hours
33. How long do you think it's REASONABLE to take to get to where you were going in a big evacuation like Floyd? (WOULD IT BE MORE OR LESS THAN 2 HOURS?) (USE 1 HOUR INCREMENTS) (TAKE MIDPOINT) (99.9=DK) (ROUND TO NEAREST ½ HOUR)
_____ Hours

34. In places where traffic was moving very slowly, what do you believe was the main cause for the delays? (CATEGORIZE; PROBE UP TO 3)
- a 0/1 Heavy traffic
 - b 0/1 Too many people left at one time
 - c 0/1 Too many people waited too long to leave
 - d 0/1 Road construction
 - e 0/1 Traffic accidents
 - f 0/1 Poor traffic management
 - g 0/1 Needed to use all available lanes for evacuating traffic (i.e., one-way)
 - h 0/1 Bad weather
 - i 0/1 Other, _____
 - j 0/1 Don't Know
35. While on the road during the evacuation, did you experience any difficulties such as running out of gasoline, your car breaking down, or needing food, water, or a restroom? (CATEGORIZE – PROBE UP TO 3)
- a 0/1 Yes, ran out of gasoline
 - b 0/1 Yes, car broke down/overheated
 - c 0/1 Yes, needed water
 - d 0/1 Yes, needed food
 - d 0/1 Yes, needed restroom
 - e 0/1 No
 - f 0/1 Other, _____
 - g 0/1 Don't Know
36. After the storm had passed, did you have any difficulties returning to your home? (CATEGORIZE – PROBE UP TO 3)
- a 0/1 Yes, couldn't get information about returning home (when/how)
 - b 0/1 Yes, roads were blocked by damage or flooding
 - c 0/1 Yes, traffic was congested returning (i.e., traffic delays)
 - d 0/1 Yes, authorities wouldn't allow entry into damaged neighborhood
 - e 0/1 No
 - f 0/1 Other
 - g 0/1 Don't Know
37. Did you or anyone in your household require assistance in evacuating?
- 1 Yes
 - 2 No (SKIP TO Q40)
 - 3 Not sure (SKIP TO Q40)
38. Did the person just need transportation, or did they have a disability or medical problem that required special assistance?
- 1 Transportation only
 - 2 Special need (disability or medical problem)
 - 3 Both
 - 4 Other, specify: _____
 - 5 Don't know
39. Was that assistance provided by someone within your household, or by an outside agency, or by a friend or relative outside your household?
- 1 Within household
 - 2 Friend/relative (outside)
 - 3 Outside agency
 - 4 Other, _____
 - 9 Don't know
40. How many vehicles were available in your household that you could have used to evacuate?
- ____ Number of vehicles (IF 0, GO TO Q41; OTHERWISE GO TO Q42)
 (9 = DK) (IF 1 OR MORE IN Q40, SKIP TO Q42) (8 =NA) (RECORD "0" IF NO VEHICLES ARE AVAILABLE)
41. Did your household members leave in someone else's vehicle, did they use public transportation, or did you evacuate another way?
- 1 Other's vehicles (GO TO Q44)
 - 2 Public transportation (GO TO Q44)
 - 3 Other, specify: _____ (GO TO Q44)
 - 9 Don't know (GO TO Q44)

42. How many vehicles did your household take in evacuating? (9 = DK) (8 =NA) (RECORD "0" IF NO VEHICLES WERE TAKEN)

_____ Number of vehicles

43. When you evacuated, did you take a motor home or pull a trailer, boat, or camper?

- 1 Yes
2 No
3 Other, specify: _____
9 Don't know

44. During the threat, did you hear either directly or indirectly anyone in an official position - such as elected officials, emergency management, police, etc. - say that you **should** evacuate from your location to a safer place?

- 1 Yes (GO TO Q45)
2 No (GO TO Q47)
9 Don't know (GO TO Q47)

45. Did officials recommend that you **should** evacuate or did they say it was mandatory that you **must** evacuate?

- 1 Should
2 Must
9 Don't know

46. Did police or other authorities come into your neighborhood going door-to-door or with loudspeakers, telling people to evacuate?

- 1 Yes
2 No
9 Don't know

47. Considering your experiences in Floyd, what would you do differently in the future, given the same kind of situation as you faced in Floyd? (CATEGORIZE) (PROBE UP TO 4)

- a 0/1 Would evacuate
b 0/1 Wouldn't evacuate
c 0/1 Would leave earlier
d 0/1 Would wait until later to leave
e 0/1 Would go further away
f 0/1 Wouldn't go as far away
g 0/1 Would go to public shelter
h 0/1 Wouldn't go to public shelter
i 0/1 Would use different route
j 0/1 Would fill up with gasoline before leaving
k 0/1 Would take food, medicine, other supplies
l 0/1 Nothing different
m 0/1 Other, specify: _____
n 0/1 Don't know

48. Suppose that in the future, public safety officials used a phased or staged evacuation system in your area. The idea would be to avoid too many people getting on the road at the same time and causing the roads to get clogged with traffic. If officials asked that you delay your departure for a few hours until after people from a more dangerous location in your area had begun their evacuation, would you be willing to do that?

- 1 Yes
2 Depends on proximity of the storm
3 Depends on strength of the storm
4 Depends on other factors
5 Other, _____
6 No
9 Maybe/Don't know

49. We're interested in how you got most of your information about Floyd - where the storm was; when it was going to hit; how severe it was. I'm going to list a number of different ways you might have gotten information, and I'd like you to tell me whether you relied upon that source none at all (0), a little (1), a fair amount (2), or a great deal (3). **(READ & ROTATE)**

	None	Little	Fair Amount	Great Deal	
a	0	1	2	3	Local radio stations
b	0	1	2	3	Local television stations
c	0	1	2	3	CNN on cable
d	0	1	2	3	The Weather Channel on cable
e	0	1	2	3	Other cable stations
f	0	1	2	3	The Internet * (DO YOU HAVE A COMPUTER WITH A MODEM)
g	0	1	2	3	Services like American Online or CompuServe
h	0	1	2	3	Word of mouth

IF "0" TO ALL, SKIP TO Q 54

50. Of those sources of information, did you find any one of them to have **more** accurate or useful information than the others?
- 1 Yes
2 No **(SKIP TO Q52)**
3 Don't Know/Not Sure **(SKIP TO Q52)**
51. Which one was that?
- 1 Local radio stations
2 Local television stations
3 CNN on cable
4 The Weather Channel on cable
5 Other cable channel
6 The Internet
7 Computer services like American Online or CompuServe
9 Don't know
52. Of those sources of information, did you find any one of them to have **less** accurate or useful information than the others?
- 1 Yes
2 No **(SKIP TO Q54)**
9 Don't Know/Not Sure **(SKIP TO Q54)**
53. Which one was that?
- 1 Local radio stations
2 Local television stations
4 CNN on cable
5 The Weather Channel on cable
3 Other cable channel
6 The Internet, if you have a computer
7 Computer services like American Online or CompuServe, if you have a computer
8 All equally inaccurate
9 Don't know
54. Did you or anyone in your household have to go to work while the Floyd evacuation was going on?
- 1 Yes **(GO TO Q55)**
2 No **(SKIP TO Q56)**
9 Don't Know **(SKIP TO Q56)**
55. How did that affect the way your household responded during the evacuation?
- 1 Not at all
2 Kept household from evacuating
3 Kept part of household from evacuating
4 Delayed household from evacuating
5 Delayed part of household from evacuating
6 Other, _____
9 Don't Know

56. At one point Floyd's maximum sustained winds were 155 MPH. That's almost a category 5 hurricane, stronger than hurricane Andrew. If Floyd had made landfall near your location with winds of 155 MPH, do you believe your home would have been at risk to dangerous flooding from storm surge or waves?
- 1 Yes
2 No
9 Don't Know/Depends
57. Considering both wind and water, do you think it would have been safe for you to have stayed in your home if Floyd had hit near your location with winds of 155 MPH?
- 1 Yes
2 No
9 Don't Know/Depends
58. Later, Floyd's maximum sustained winds decreased to 125 MPH. That's a strong category 3 hurricane, almost as strong as hurricane Hugo. If Floyd had made landfall near your location with winds of 125 MPH, do you believe your home would have been at risk to dangerous flooding from storm surge or waves?
- 1 Yes
2 No
9 Don't Know/Depends
59. Considering both wind and water, do you think it would have been safe for you to have stayed in your home if Floyd had hit near your location with winds of 125 MPH?
- 1 Yes
2 No
9 Don't Know/Depends
60. In Floyd, what kinds of steps, if any, did you take before the storm arrived to protect your property? **(CATEGORIZE)**
(PROBE UP TO 3)
- a 0/1 Apply window protection
b 0/1 Apply door/garage door protection
c 0/1 Secure or remove loose objects from yard
d 0/1 Move boat, camper, etc.
e 0/1 Prepare pool
f 0/1 Elevate furniture, appliance, rugs, etc.
g 0/1 Protect documents, photos, etc.
h 0/1 Sandbag property
i 0/1 Purchase items for repair after/during storm (plastic film, plywood)
j 0/1 Buy/rent generator
k 0/1 Secure plants
l 0/1 Cut limbs
m 0/1 Other (Specify) _____
n 0/1 None
o 0/1 Don't Know/Not Sure
61. Have you identified the safest location in your home to ride out a strong hurricane if you had to?
- 1 Yes
2 No
9 Don't Know/Not Sure
62. Do you have any kind of window protection such as storm shutters, security film, or plywood sheets designed to protect the windows during a strong hurricane?
- 1 Yes **(GO TO Q63)**
2 No **(SKIP TO Q64)**
9 Don't Know/Not Sure **(SKIP TO Q64)**
63. What kind of protection is it?
- 1 Permanent roll-down metal panels
2 Removable metal panels
3 Plywood sheets
4 Security Film
5 Impact-resistant glass
6 Other
9 Don't Know/Not Sure

IF ANSWERING Q63, SKIP TO Q65

64. If not, why not? (CATEGORIZE)

- 1 Don't need it
- 2 Too expensive
- 3 Don't think it works
- 4 Don't have enough time to do it
- 5 Other (specify) _____
- 9 Don't know

65. About how much do you think window protection such as storm shutters would cost per window? (PAUSE - READ IF NECESSARY)

- 1 Under \$10
- 2 \$10 to \$50
- 3 \$50 to \$100
- 4 \$100 to \$200
- 5 \$200 to \$500
- 6 Over \$500
- 9 Don't Know/Not Sure

66. Do you believe window protection like that would mainly just prevent the windows from breaking and reduce the danger of flying glass, or do you believe they would also significantly reduce the total damage your house would suffer in other ways?

- 1 Mainly Windows
- 2 Total Damage Also
- 9 Don't Know/Not Sure

67. Other than window protection, what permanent improvements, if any, have you made to your home to reduce the damage to your property in a hurricane? (CATEGORIZE) (PROBE UP TO 2)

- a 0/1 Roof/truss Strengthening
- b 0/1 Door/Garage Door Protection
- c 0/1 Flood proofing
- d 0/1 Other (Specify) _____
- e 0/1 None
- f 0/1 Don't Know/Not Sure

68. Is your home or building elevated on pilings or fill material to raise it above flood water?

- 1 Yes
- 2 No
- 9 Don't Know/Not Sure

69. How much money do you plan to spend **this year** on changes to your home to make it stronger or safer from hurricanes? (999=DK)

\$ _____

70. If your homeowners insurance company offered to reduce the price of your insurance premium by 15% if you were to make your home stronger by installing permanent window protection such as storm shutters, would you be willing to it? (IF NO, PROBE WHY NOT)

- 1 Yes
- 2 No, already have window protection
- 3 No, would cost more than it saved
- 4 No, would look unattractive
- 5 No, don't need them in this area
- 6 No, don't own home
- 7 No, other
- 8 Depends on Cost/Savings
- 9 Don't Know

71. What was the most damage, in dollars, you've ever experienced to your property as the result of a hurricane?

- 1 None
- 2 Less than \$1,000
- 3 \$1,000 to \$4,999
- 4 \$5,000 to \$9,999
- 5 \$10,000 to \$24,999
- 6 \$25,000 to \$49,999
- 7 \$50,000 or more
- 8 Don't Know/Refused

NOW WE HAVE JUST A FEW MORE QUESTIONS FOR BACKGROUND PURPOSES ONLY.

72. Which of the following types of structures do you live in? Do you live in a: **(READ)**
- 1 Detached single family home?
 - 2 Duplex, triplex, quadplex home?
 - 3 Multi-family building -- 2 stories or less? (Apartment/condo)
 - 4 Multi-family building -- 3 to 6 stories (Apartment/condo)
 - 5 Multi-family building -- more than 6 stories (Apartment/condo)
 - 6 Some other type of structure
 - 9 Don't Know
 - 10 Refused
73. How close do you live to the beachfront? **(READ)**
- 1 On the Beachfront?
 - 2 One block or less?
 - 3 More than a block but less than a mile
 - 4 More than a mile
 - 9 Don't Know
 - 10 Refused
74. How close do you live any other water body such as a bay, river, or sound? **(READ)**
- 1 On the waterfront?
 - 2 One block or less?
 - 3 More than a block but less than a mile
 - 4 More than a mile
 - 9 Don't Know
 - 10 Refused
75. How old were you on your last birthday?
____ Number of years **(99 = DK) (88=REFUSED)**
76. How long have you lived in your present home? **(ROUND UP) (99 = DK) (88=REFUSED)**
____ Number of years
77. How long have you lived in the Tampa Bay Region? **(ROUND UP) (99 = DK)(88=REFUSED)**
____ Number of years
78. How many people live in your household, including yourself? **(99 = DK) (88=REFUSED)**
____ Number of people **(IF 1, SKIP TO Q60)**
79. How many of these are children, 17 or younger? **(99 = DK) (88=REFUSED)**
____ Number of children
80. Do you own your home or rent?
- 1 Own
 - 2 Rent
 - 3 Other
81. Do you have any pets?
- 1 Yes
 - 2 No
 - 9 Refused
82. Which race or ethnic background best describes you? **(READ)**
- 1 African American or Black
 - 2 Asian
 - 3 Caucasian or White
 - 4 Hispanic
 - 5 American Indian
 - 6 Other _____
 - 9 Refused
83. Which of the following ranges best describes your total household income for 1996? **(READ)**
- 1 Less than \$15,000
 - 2 \$15,000 to \$24,999
 - 3 \$25,000 to \$39,999
 - 4 \$40,000 to \$79,999
 - 5 Over \$80,000
 - 9 Refused

84. Which category best describes your education level?
- 1 Some high school
 - 2 High school graduate
 - 3 Some college
 - 4 College graduate
 - 5 Post graduate
 - 9 Refused

Thank you so much. Sometimes my supervisor will call people to check on my work. May I get your first name in case she wants to check?

85. _____

RECORD INTERVIEW INFORMATION ON RESPONDENT DISPOSITION SHEET

86. Sex of respondent 1 Male 2 Female

87. Interviewer ID _____

88. Date of survey _____

89. Phone number _____

90. Risk Zone 1 = High Risk/Cat 1
 2 = Moderate Risk/Cat 3-5
 3 = Coastal Non-Surge
 4 = Non-coastal

91. State 1 = Florida
 2 = Alabama
 3 = Mississippi
 4 = Louisiana

92. Sample Area

- 1 = Dade/Broward, Florida
- 2 = Treasure Coast, Florida
- 3 = East Central, Florida
- 4 = Northeast, Florida
- 5 = Brunswick, Georgia
- 6 = Savannah, Georgia
- 7 = Beaufort, South Carolina
- 8 = Charleston, South Carolina
- 9 = Myrtle Beach, South Carolina
- 10 = Southeast, North Carolina
- 11 = Northeast, North Carolina

Appendix D

Evacuation Behavioral Data by Interviewed Area

Selected Evacuation Data in Floyd

Southeast Florida Region (Dade/Broward)

Percent who left their homes in Floyd, by risk zone

	Cat 1 Surge Zone (N=201)	Other Surge Zones (N=204)	Coast Non- Surge (N=204)
Evacuated	34	12	10

Percent of evacuees by destination, by risk zone

	Cat 1 Surge Zone (N=66)	Other Surge Zones (N=16)	Coast Non- Surge (N=16)
Own Neighborhood	17	44	19
Own County	52	56	44
Out of County	32	0	38

Percent of out-of-county evacuees, by state destination

Florida	88
Georgia	3
Other	9

Hours Required to Reach Destination (percent of evacuees)

	Cat 1 Surge Zone	Other Surge Zones	Coastal County Non-surge
Less than 2	84	71	88
2 to 5	12	10	6
5 to 10	3	19	6
10 or more	2	0	0

Hours More Than Expected to Reach Destination (percent of evacuees)

Less than 2	98
2 to 5	2
5 to 10	0
10 or more	0

Types of Refuge Used by Evacuees (percent)

	Cat 1 Surge Zone N=60	Other Surge Zones N=23	Coastal County Non-Surge N=16
Public Shelter	3	17	0
Church	0	0	6
Friend/Relative	73	70	81
Hotel/Motel	15	9	6
Workplace	2	0	0
Other	7	4	0

Greatest Influence to Leave (percent of evacuees)

	Cat 1 Surge Zone N=66	Other Surge Zones N=22	Coastal County Non-surge N=16
Media Info from Gov't Officials	61	50	56
Other Media Info	29	27	25
Info from Friends	17	14	25
Other	3	27	0
Don't Know	2	0	0

Heard Evacuation Notices from Officials (percent of respondents; excludes "Don't Know" responses)

	Cat 1 Surge Zone	Other Surge Zones	Coastal County Non-Surge
Heard Should or Must Leave	45	17	8

Greatest Influence for Going Out of County (percent of out-of-county evacuees)

	Cat 1 Surge Zone N=20	Other Surge Zones N=7	Coastal County Non-surge N=6
Media Info from Gov't Officials	30	43	49
Other Media Info	30	29	27
Info from Friends	30	29	24
Other	5	14	12
Don't Know	5	0	0

Sources Relied On a "Great Deal" for Information about Floyd (percent of respondents)

Local Radio	32
Local Television	86
CNN	23
Weather Channel	43
Other Cable	6
Internet	5
AOL	2
Word of Mouth	10

Selected Evacuation Data in Floyd

Treasure Coast, FL Region

(includes Vero Beach, Ft. Pierce, Palm Beach)

Percent who left their homes in Floyd, by risk zone

	Cat 1 Surge Zone (N=199)	Other Surge Zones (N=204)	Coast Non- Surge (N=99)	Non-Coastal Counties (N=111)
Evacuated	39	25	23	22

Percent of evacuees by destination, by risk zone

	Cat 1 Surge Zone (N=79)	Other Surge Zones (N=49)	Coast Non- Surge (N=20)	Non-Coastal Counties (N=24)
Own Neighborhood	23	18	25	19
Own County	25	31	25	13
Out of County	52	51	50	46

Percent of out-of-county evacuees, by state destination

Florida	93
Georgia	5
North Carolina	1
Other	1

Hours Required to Reach Destination (percent of evacuees)

	Cat 1 Surge Zone	Other Surge Zones	Coastal County Non-surge	Non-coastal Counties
Less than 2	52	67	70	67
2 to 5	33	18	15	17
5 to 10	14	12	15	8
10 or more	1	2	0	0

Hours More Than Expected to Reach Destination (percent of evacuees)

Less than 2	93
2 to 5	6
5 to 10	1
10 or more	0

Types of Refuge Used by Evacuees (percent)

	Cat 1 Surge Zone N=76	Other Surge Zones N=48	Coastal County Non-Surge N=20	Non-coastal Counties N=24
Public Shelter	1	8	0	4
Church	0	2	0	0
Friend/Relative	59	56	80	63
Hotel/Motel	34	25	20	21
Workplace	3	6	0	0
Other	3	2	0	12

Greatest Influence to Leave (percent of evacuees)

	Cat 1 Surge Zone N=38	Other Surge Zones N=13	Coastal County Non-surge N=8	Non-coastal Counties N=13
Media Info from Gov't Officials	42	54	38	23
Other Media Info	34	31	38	39
Info from Friends	32	23	38	54
Other	13	0	0	0
Don't Know	0	9	0	0

Heard Evacuation Notices from Officials (percent of respondents; excludes "Don't Know" responses)

	Cat 1 Surge Zone	Other Surge Zones	Coastal County Non-Surge	Non-coastal Counties
Heard Should or Must Leave	36	18	12	10

Greatest Influence for Going Out of County (percent of out-of-county evacuees)

	Cat 1 Surge Zone N=25	Other Surge Zones N=9	Coastal County Non-surge N=4	Non-coastal Counties N=6
Media Info from Gov't Officials	20	67	50	17
Other Media Info	48	33	50	50
Info from Friends	28	11	0	0
Other	12	11	0	0
Don't Know	12	11	0	0

Sources Relied On a Great Deal for Information about Floyd (percent of respondents)

Local Radio	22
Local Television	75
CNN	22
Weather Channel	52
Other Cable	7
Internet	5
AOL	2
Word of Mouth	7

Selected Evacuation Data in Floyd

East Central FL Region (includes Daytona, Melbourne)

Percent who left their homes in Floyd, by risk zone

	Cat 1 Surge Zone (N=204)	Other Surge Zones (N=201)	Coast Non- Surge (N=100)	Non-Coastal Counties (N=100)
Evacuated	74	52	42	12

Percent of evacuees by destination, by risk zone

	Cat 1 Surge Zone (N=146)	Other Surge Zones (N=103)	Coast Non- Surge (N=41)	Non-Coastal Counties (N=11)
Own Neighborhood	3	10	7	27
Own County	23	10	12	45
Out of County	77	80	80	27

Percent of out-of-county evacuees, by state destination

Florida	84
Georgia	10
South Carolina	1
North Carolina	1
Virginia	<1
Alabama	3
Tennessee	<1
Other	<1

Hours Required to Reach Destination (percent of evacuees)

	Cat 1 Surge Zone	Other Surge Zones	Coastal County Non-surge	Non-coastal Counties
Less than 2	45	32	26	83
2 to 5	32	16	36	8
5 to 10	17	32	21	0
10 to 15	3	12	14	8
15 to 20	1	6	2	0
20 or more	2	3	0	0

Hours More Than Expected to Reach Destination (percent of evacuees)

Less than 2	70
2 to 5	18
5 to 10	9
10 or more	3

Types of Refuge Used by Evacuees (percent)

	Cat 1 Surge Zone N=149	Other Surge Zones N=101	Coastal County Non-Surge N=40	Non-coastal Counties N=10
Public Shelter	4	5	0	0
Church	0	4	0	0
Friend/Relative	56	53	70	50
Hotel/Motel	36	28	28	40
Workplace	1	1	0	0
Other	4	10	3	10

Greatest Influence to Leave (percent of evacuees)

	Cat 1 Surge Zone N=148	Other Surge Zones N=103	Coastal County Non-surge N=39	Non-coastal Counties N=12
Media Info from Gov't Officials	51	55	46	58
Other Media Info	47	35	31	25
Info from Friends	18	18	26	33
Other	4	6	26	33
Don't Know	0	2	3	0

Heard Evacuation Notices from Officials (percent of respondents; excludes "Don't Know" responses)

	Cat 1 Surge Zone	Other Surge Zones	Coastal County Non-Surge	Non-coastal Counties
Heard Should or Must Leave	61	35	21	11

Greatest Influence for Going Out of County (percent of out-of-county evacuees)

	Cat 1 Surge Zone N=110	Other Surge Zones N=81	Coastal County Non-surge N=33	Non-coastal Counties N=3
Media Info from Gov't Officials	36	41	48	67
Other Media Info	37	27	27	0
Info from Friends	29	28	24	33
Other	7	15	12	0
Don't Know	2	0	0	0

Sources Relied On a Great Deal for Information about Floyd (percent of respondents)

Local Radio	24
Local Television	79
CNN	24
Weather Channel	51
Other Cable	5
Internet	4
AOL	2
Word of Mouth	11

Selected Evacuation Data in Floyd

Northeast Florida (includes Jacksonville)

Percent who left their homes in Floyd, by risk zone

	Cat 1 Surge Zone (N=205)	Other Surge Zones (N=201)	Coast Non- Surge (N=100)	Non-Coastal Counties (N=110)
Evacuated	80	44	29	24

Percent of evacuees by destination, by risk zone

	Cat 1 Surge Zone	Other Surge Zones	Coast Non- Surge	Non-Coastal Counties
Own Neighborhood	5	13	11	31
Own County	20	9	15	15
Out of County	75	78	74	54

Percent of out-of-county evacuees, by state destination

Florida	55
Georgia	32
South Carolina	1
North Carolina	4
Virginia	
Alabama	7
Tennessee	<1
Other	<1

Hours Required to Reach Destination (percent of evacuees)

	Cat 1 Surge Zone	Other Surge Zones	Coastal County Non-surge	Non-coastal Counties
Less than 2	38	31	28	38
2 to 5	20	28	24	33
5 to 10	29	24	35	21
10 to 15	8	12	7	8
15 to 20	4	2	3	0
20 or more	1	2	3	0

Hours More Than Expected to Reach Destination (percent of evacuees)

Less than 2	69
2 to 5	15
5 to 10	14
10 or more	3

Types of Refuge Used by Evacuees (percent)

	Cat 1 Surge Zone N=163	Other Surge Zones N=89	Coastal County Non-Surge N=26	Non-coastal Counties N=25
Public Shelter	4	9	4	4
Church	1	3	0	4
Friend/Relative	51	47	65	52
Hotel/Motel	32	30	23	24
Workplace	3	2	0	0
Other	10	8	7	16

Greatest Influence to Leave (percent of evacuees)

	Cat 1 Surge Zone N=164	Other Surge Zones N=79	Coastal County Non-surge N=21	Non-coastal Counties N=24
Media Info from Gov't Officials	58	49	33	63
Other Media Info	33	33	14	21
Info from Friends	14	17	38	4
Other	11	11	24	21
Don't Know	1	0	0	0

Heard Evacuation Notices from Officials (percent of respondents; excludes "Don't Know" responses)

	Cat 1 Surge Zone	Other Surge Zones	Coastal County Non-Surge	Non-coastal Counties
Heard Should or Must Leave	69	42	26	16

Greatest Influence for Going Out of County (percent of out-of-county evacuees)

	Cat 1 Surge Zone N=122	Other Surge Zones N=65	Coastal County Non-surge N=18	Non-coastal Counties N=14
Media Info from Gov't Officials	51	46	39	71
Other Media Info	23	23	17	21
Info from Friends	22	15	39	7
Other	14	19	17	14
Don't Know	3	2	0	0

Sources Relied On a Great Deal for Information about Floyd (percent of respondents)

Local Radio	28
Local Television	78
CNN	15
Weather Channel	52
Other Cable	6
Internet	5
AOL	3
Word of Mouth	10

Selected Evacuation Data in Floyd

South Georgia Region (includes Brunswick)

Percent who left their homes in Floyd, by risk zone

	Cat 1 Surge Zone (N=300)	Other Surge Zones (N=198)	Non-Coastal Counties (N=103)
Evacuated	89	75	27

Percent of evacuees by destination, by risk zone

	Cat 1 Surge Zone (N=261)	Other Surge Zones (N=149)	Non-Coastal Counties (N=25)
Own Neighborhood	2	4	12
Own County	3	4	0
Out of County	95	92	88

Percent of out-of-county evacuees, by state destination

Florida	6
Georgia	83
South Carolina	2
North Carolina	2
Alabama	4
Tennessee	1
Other	1

Hours Required to Reach Destination (percent of evacuees)

	Cat 1 Surge Zone	Other Surge Zones	Non-coastal Counties
Less than 2	16	7	36
2 to 5	19	19	36
5 to 10	48	47	24
10 to 15	14	23	4
15 to 20	2	1	0
20 or more	1	2	0

Hours More Than Expected to Reach Destination (percent of evacuees)

Less than 2	45
2 to 5	30
5 to 10	21
10 or more	4

Types of Refuge Used by Evacuees (percent)

	Cat 1 Surge Zone N=265	Other Surge Zones N=149	Non-coastal Counties N=25
Public Shelter	2	5	4
Church	2	3	0
Friend/Relative	59	64	76
Hotel/Motel	26	20	4
Workplace	1	1	4
Other	10	7	12

Greatest Influence to Leave (percent of evacuees)

	Cat 1 Surge Zone N=259	Other Surge Zones N=147	Non-coastal Counties N=26
Media Info from Gov't Officials	61	54	39
Other Media Info	31	29	54
Info from Friends	14	20	15
Other	4	1	0
Don't Know	<1	1	0

Heard Evacuation Notices from Officials (percent of respondents; excludes "Don't Know" responses)

	Cat 1 Surge Zone	Other Surge Zones	Non-coastal Counties
Heard Should or Must Leave	75	66	29

Greatest Influence for Going Out of County (percent of out-of-county evacuees)

	Cat 1 Surge Zone N=244	Other Surge Zones N=134	Non-coastal Counties N=22
Media Info from Gov't Officials	48	49	46
Other Media Info	30	20	32
Info from Friends	26	34	27
Other	5	2	5
Don't Know	1	0	0

Sources Relied On a Great Deal for Information about Floyd (percent of respondents)

Local Radio	38
Local Television	68
CNN	22
Weather Channel	62
Other Cable	5
Internet	3
AOL	<1
Word of Mouth	14

Selected Evacuation Data in Floyd

North Georgia Region (includes Savannah)

Percent who left their homes in Floyd, by risk zone

	Cat 1 Surge Zone (N=210)	Other Surge Zones (N=205)	Coast Non- Surge (N=107)	Non-Coastal Counties (N=104)
Evacuated	90	86	61	33

Percent of evacuees by destination, by risk zone

	Cat 1 Surge Zone	Other Surge Zones	Coast Non- Surge	Non-Coastal Counties
Own Neighborhood	<1	<1	3	9
Own County	6	2	2	3
Out of County	94	97	95	88

Percent of out-of-county evacuees, by state destination

Florida	1
Georgia	84
South Carolina	4
North Carolina	4
Virginia	<1
Alabama	3
Tennessee	1
Other	<1

Hours Required to Reach Destination (percent of evacuees)

	Cat 1 Surge Zone	Other Surge Zones	Coastal County Non-surge	Non-coastal Counties
Less than 2	21	16	5	18
2 to 5	21	18	22	52
5 to 10	28	33	41	30
10 to 15	21	22	25	0
15 to 20	3	5	3	0
20 or more	5	6	5	0

Hours More Than Expected to Reach Destination (percent of evacuees)

Less than 2	48
2 to 5	23
5 to 10	23
10 or more	7

Types of Refuge Used by Evacuees (percent)

	Cat 1 Surge Zone N=189	Other Surge Zones N=177	Coastal County Non-Surge N=61	Non-coastal Counties N=33
Public Shelter	2	3	7	0
Church	1	7	7	6
Friend/Relative	65	61	62	67
Hotel/Motel	27	21	15	15
Workplace	0	0	3	3
Other	5	8	7	9

Greatest Influence to Leave (percent of evacuees)

	Cat 1 Surge Zone N=185	Other Surge Zones N=158	Coastal County Non-surge N=64	Non-coastal Counties N=33
Media Info from Gov't Officials	54	56	55	49
Other Media Info	32	25	38	21
Info from Friends	18	25	19	27
Other	15	8	2	9
Don't Know	1	1	0	0

Heard Evacuation Notices from Officials (percent of respondents; excludes "Don't Know" responses)

	Cat 1 Surge Zone	Other Surge Zones	Coastal County Non-Surge	Non-coastal Counties
Heard Should or Must Leave	79	77	70	29

Greatest Influence for Going Out of County (percent of out-of-county evacuees)

	Cat 1 Surge Zone N=170	Other Surge Zones N=148	Coastal County Non-surge N=57	Non-coastal Counties N=29
Media Info from Gov't Officials	51	44	47	38
Other Media Info	23	15	25	28
Info from Friends	21	32	21	31
Other	19	18	11	10
Don't Know	1	0	0	0

Sources Relied On a Great Deal for Information about Floyd (percent of respondents)

Local Radio	34
Local Television	74
CNN	18
Weather Channel	62
Other Cable	5
Internet	5
AOL	2
Word of Mouth	16

Selected Evacuation Data in Floyd

Southern SC Region (includes Beaufort)

Percent who left their homes in Floyd, by risk zone

	Cat 1 Surge Zone (N=198)	Other Surge Zones (N=198)	Coast Non- Surge (N=106)	Non-Coastal Counties (N=105)
Evacuated	88	80	64	26

Percent of evacuees by destination, by risk zone

	Cat 1 Surge Zone (N=174)	Other Surge Zones (N=155)	Coast Non- Surge (N=68)	Non-Coastal Counties (N=28)
Own Neighborhood	0	0	3	21
Own County	2	1	3	11
Out of County	98	99	94	68

Percent of out-of-county evacuees, by state destination

Florida	1
Georgia	43
South Carolina	35
North Carolina	13
Virginia	1
Alabama	2
Tennessee	3
Other	2

Hours Required to Reach Destination (percent of evacuees)

	Cat 1 Surge Zone	Other Surge Zones	Coastal County Non-surge	Non-coastal Counties
Less than 2	5	4	18	39
2 to 5	24	13	21	19
5 to 10	39	39	43	42
10 to 15	22	32	10	0
15 to 20	9	8	7	0
20 or more	2	4	2	0

Hours More Than Expected to Reach Destination (percent of evacuees)

Less than 2	44
2 to 5	23
5 to 10	24
10 or more	9

Types of Refuge Used by Evacuees (percent)

	Cat 1 Surge Zone N=173	Other Surge Zones N=152	Coastal County Non-Surge N=66	Non-coastal Counties N=25
Public Shelter	1	2	5	4
Church	1	1	2	0
Friend/Relative	43	55	52	72
Hotel/Motel	51	35	36	16
Workplace	1	1	0	0
Other	4	6	6	8

Greatest Influence to Leave (percent of evacuees)

	Cat 1 Surge Zone N=174	Other Surge Zones N=157	Coastal County Non-surge N=67	Non-coastal Counties N=26
Media Info from Gov't Officials	43	50	54	65
Other Media Info	45	30	43	54
Info from Friends	12	16	16	8
Other	12	13	0	8
Don't Know	1	1	2	0

Heard Evacuation Notices from Officials (percent of respondents; excludes "Don't Know" responses)

	Cat 1 Surge Zone	Other Surge Zones	Coastal County Non-Surge	Non-coastal Counties
Heard Should or Must Leave	72	68	64	31

Greatest Influence for Going Out of County (percent of out-of-county evacuees)

	Cat 1 Surge Zone N=171	Other Surge Zones N=154	Coastal County Non-surge N=63	Non-coastal Counties N=19
Media Info from Gov't Officials	37	44	38	32
Other Media Info	37	28	46	53
Info from Friends	17	23	21	21
Other	19	12	10	5
Don't Know	1	1	0	0

Sources Relied On a Great Deal for Information about Floyd (percent of respondents)

Local Radio	32
Local Television	68
CNN	21
Weather Channel	61
Other Cable	5
Internet	7
AOL	2
Word of Mouth	14

Selected Evacuation Data in Floyd

Central SC Region (includes Charleston)

Percent who left their homes in Floyd, by risk zone

	Cat 1 Surge Zone (N=203)	Other Surge Zones (N=211)	Coast Non- Surge (N=99)	Non-Coastal Counties (N=98)
Evacuated	78	68	69	47

Percent of evacuees by destination, by risk zone

	Cat 1 Surge Zone	Other Surge Zones	Coast Non- Surge	Non-Coastal Counties
Own Neighborhood	3	7	1	5
Own County	6	6	4	2
Out of County	91	87	95	93

Percent of out-of-county evacuees, by state destination

Florida	<1
Georgia	17
South Carolina	45
North Carolina	25
Virginia	2
Alabama	2
Tennessee	5
Other	3

Hours Required to Reach Destination (percent of evacuees)

	Cat 1 Surge Zone	Other Surge Zones	Coastal County Non-surge	Non-coastal Counties
Less than 2	9	14	9	16
2 to 5	17	22	10	11
5 to 10	31	31	24	44
10 to 15	31	31	24	44
15 to 20	9	12	18	11
20 or more	9	4	6	0

Hours More Than Expected to Reach Destination (percent of evacuees)

Less than 2	40
2 to 5	21
5 to 10	23
10 or more	17

Types of Refuge Used by Evacuees (percent)

	Cat 1 Surge Zone N=159	Other Surge Zones N=143	Coastal County Non-Surge N=64	Non-coastal Counties N=46
Public Shelter	1	1	2	2
Church	0	2	2	0
Friend/Relative	59	64	64	65
Hotel/Motel	31	27	28	28
Workplace	1	1	2	0
Other	8	4	3	4

Greatest Influence to Leave (percent of evacuees)

	Cat 1 Surge Zone N=157	Other Surge Zones N=143	Coastal County Non-surge N=66	Non-coastal Counties N=43
Media Info from Gov't Officials	60	63	46	70
Other Media Info	31	23	32	23
Info from Friends	7	7	9	8
Other	9	6	18	5
Don't Know	2	1	3	3

Heard Evacuation Notices from Officials (percent of respondents; excludes "Don't Know" responses)

	Cat 1 Surge Zone	Other Surge Zones	Coastal County Non-Surge	Non-coastal Counties
Heard Should or Must Leave	80	78	73	50

Greatest Influence for Going Out of County (percent of out-of-county evacuees)

	Cat 1 Surge Zone N=145	Other Surge Zones N=126	Coastal County Non-surge N=64	Non-coastal Counties N=37
Media Info from Gov't Officials	50	56	34	60
Other Media Info	26	18	22	24
Info from Friends	9	18	25	16
Other	14	10	20	16
Don't Know	2	1	3	0

Sources Relied On a Great Deal for Information about Floyd (percent of respondents)

Local Radio	34
Local Television	73
CNN	14
Weather Channel	49
Other Cable	4
Internet	9
AOL	4
Word of Mouth	9

Selected Evacuation Data in Floyd

Northern SC Region (includes Myrtle Beach)

Percent who left their homes in Floyd, by risk zone

	Cat 1 Surge Zone (N=208)	Other Surge Zones (N=206)	Coast Non- Surge (N=128)	Non-Coastal Counties (N=109)
Evacuated	67	61	37	21

Percent of evacuees by destination, by risk zone

	Cat 1 Surge Zone (N=136)	Other Surge Zones (N=122)	Coast Non- Surge (N=48)	Non-Coastal Counties (N=23)
Own Neighborhood	5	6	33	57
Own County	16	11	10	17
Out of County	79	83	56	26

Percent of out-of-county evacuees, by state destination

Florida	<1
Georgia	8
South Carolina	47
North Carolina	33
Virginia	5
Alabama	<1
Tennessee	3
Other	4

Hours Required to Reach Destination (percent of evacuees)

	Cat 1 Surge Zone	Other Surge Zones	Coastal County Non-surge	Non-coastal Counties
Less than 2	29	34	55	91
2 to 5	36	31	21	9
5 to 10	30	23	19	0
10 to 15	3	7	4	0
15 to 20	1	3	0	0
20 or more	1	3	0	0

Hours More Than Expected to Reach Destination (percent of evacuees)

Less than 2	85
2 to 5	8
5 to 10	5
10 or more	2

Types of Refuge Used by Evacuees (percent)

	Cat 1 Surge Zone N=132	Other Surge Zones N=121	Coastal County Non-Surge N=47	Non-coastal Counties N=23
Public Shelter	2	3	6	0
Church	0	3	6	13
Friend/Relative	67	60	68	70
Hotel/Motel	24	28	13	13
Workplace	0	2	2	4
Other	8	5	4	0

Greatest Influence to Leave (percent of evacuees)

	Cat 1 Surge Zone N=137	Other Surge Zones N=121	Coastal County Non-surge N=46	Non-coastal Counties N=22
Media Info from Gov't Officials	46	60	44	55
Other Media Info	32	29	41	18
Info from Friends	18	10	22	27
Other	8	5	2	5
Don't Know	2	2	7	0

Heard Evacuation Notices from Officials (percent of respondents; excludes "Don't Know" responses)

	Cat 1 Surge Zone	Other Surge Zones	Coastal County Non-Surge	Non-coastal Counties
Heard Should or Must Leave	69	56	26	20

Greatest Influence for Going Out of County (percent of out-of-county evacuees)

	Cat 1 Surge Zone N=114	Other Surge Zones N=99	Coastal County Non-surge N=27	Non-coastal Counties N=5
Media Info from Gov't Officials	33	51	52	20
Other Media Info	30	17	22	20
Info from Friends	28	25	41	40
Other	15	9	0	20
Don't Know	3	4	4	0

Sources Relied On a Great Deal for Information about Floyd (percent of respondents)

Local Radio	28
Local Television	76
CNN	27
Weather Channel	61
Other Cable	7
Internet	6
AOL	2
Word of Mouth	10

Selected Evacuation Data in Floyd

Southeastern NC (Wilmington Region)

Percent who left their homes in Floyd, by risk zone

	Cat 1 Surge Zone (N=195)	Other Surge Zones (N=198)	Coast Non- Surge (N=103)	Non-Coastal Counties (N=102)
Evacuated	57	44	30	28

Percent of evacuees by destination, by risk zone

	Cat 1 Surge Zone	Other Surge Zones	Coast Non- Surge	Non-Coastal Counties
Own Neighborhood	15	17	30	25
Own County	24	13	10	50
Out of County	61	70	60	25

Percent of out-of-county evacuees, by state destination

Georgia	2
South Carolina	9
North Carolina	73
Virginia	8
Tennessee	1
Other (north of VA)	7

Hours Required to Reach Destination (percent of evacuees)

	Cat 1 Surge Zone	Other Surge Zones	Coastal County Non-surge	Non-coastal Counties
Less than 2	54	43	52	81
2 to 5	27	22	19	10
5 to 10	17	30	19	3
10 or more	2	5	0	6

Hours More Than Expected to Reach Destination (percent of evacuees)

Less than 2	86
2 to 5	10
5 to 10	4
10 or more	<1

Types of Refuge Used by Evacuees (percent)

	Cat 1 Surge Zone N=105	Other Surge Zones N=83	Coastal County Non-Surge N=30	Non-coastal Counties N=28
Public Shelter	1	2	0	0
Church	0	4	3	0
Friend/Relative	73	64	77	79
Hotel/Motel	19	22	7	11
Workplace	4	0	10	0
Other	3	8	3	11

Greatest Influence to Leave (percent of evacuees)

	Cat 1 Surge Zone N=109	Other Surge Zones N=87	Coastal County Non-surge N=31	Non-coastal Counties N=30
Media Info from Gov't Officials	55	40	31	17
Other Media Info	30	41	45	23
Info from Friends	19	16	19	37
Other	6	8	3	30
Don't Know	1	3	3	0

Heard Evacuation Notices from Officials (percent of respondents; excludes "Don't Know" responses)

	Cat 1 Surge Zone	Other Surge Zones	Coastal County Non-Surge	Non-coastal Counties
Heard Should or Must Leave	52	33	26	11

Greatest Influence for Going Out of County (percent of out-of-county evacuees)

	Cat 1 Surge Zone N=66	Other Surge Zones N=62	Coastal County Non-surge N=17	Non-coastal Counties N=8
Media Info from Gov't Officials	35	34	11	13
Other Media Info	32	36	41	38
Info from Friends	17	29	35	38
Other	20	8	12	13

Sources Relied On a Great Deal for Information about Floyd (percent of respondents)

Local Radio	35
Local Television	76
CNN	18
Weather Channel	65
Other Cable	8
Internet	7
AOL	2
Word of Mouth	10

Destination Data in Floyd

Eastern NC Region

Percent who left their homes in Floyd, by risk zone

	Cat 1 Surge Zone (N=199)	Other Surge Zones (N=198)	Coast Non- Surge (N=100)	Non-Coastal Counties (N=102)
Evacuated	20	19	15	18

Percent of evacuees by destination, by risk zone

	Cat 1 Surge Zone (N=39)	Other Surge Zones (N=33)	Coast Non- Surge (N=15)	Non-Coastal Counties (N=18)
Own Neighborhood	8	18	67	61
Own County	8	30	13	33
Out of County	84	52	20	6

Percent of out-of-county evacuees, by state destination

Florida	2
North Carolina	56
Virginia	33
Other	10

Hours Required to Reach Destination (percent of evacuees)

	Cat 1 Surge Zone	Other Surge Zones	Coastal County Non-surge	Non-coastal Counties
Less than 2	15	73	93	94
2 to 5	39	6	7	0
5 to 10	36	18	0	0
10 or more	10	3	0	6

Hours More Than Expected to Reach Destination (percent of evacuees)

Less than 2	86
2 to 5	9
5 to 10	5
10 or more	0

Types of Refuge Used by Evacuees (percent)

	Cat 1 Surge Zone N=39	Other Surge Zones N=33	Coastal County Non-Surge N=15	Non-coastal Counties N=18
Public Shelter	0	0	7	11
Church	0	0	13	0
Friend/Relative	44	70	60	61
Hotel/Motel	49	24	13	17
Workplace	0	0	0	6
Other	8	6	7	6

Greatest Influence to Leave (percent of evacuees)

	Cat 1 Surge Zone N=38	Other Surge Zones N=33	Coastal County Non-surge N=15	Non-coastal Counties N=18
Media Info from Gov't Officials	66	46	33	28
Other Media Info	11	21	47	28
Info from Friends	13	33	20	22
Other	11	9	7	17
Don't Know	3	0	0	6

Heard Evacuation Notices from Officials (percent of respondents; excludes "Don't Know" responses)

	Cat 1 Surge Zone	Other Surge Zones	Coastal County Non-Surge	Non-coastal Counties
Heard Should or Must Leave	56	13	6	13

Greatest Influence for Going Out of County (percent of out-of-county evacuees)

	Cat 1 Surge Zone N=31	Other Surge Zones N=17	Coastal County Non-surge N=3	Non-coastal Counties N=1
Media Info from Gov't Officials	39	29		
Other Media Info	19	18	33	
Info from Friends	36	41	67	
Other	10	12		
Don't Know	0	6		

Sources Relied On a Great Deal for Information about Floyd (percent of respondents)

Local Radio	32
Local Television	73
CNN	18
Weather Channel	60
Other Cable	8
Internet	4
AOL	2
Word of Mouth	9

Appendix E

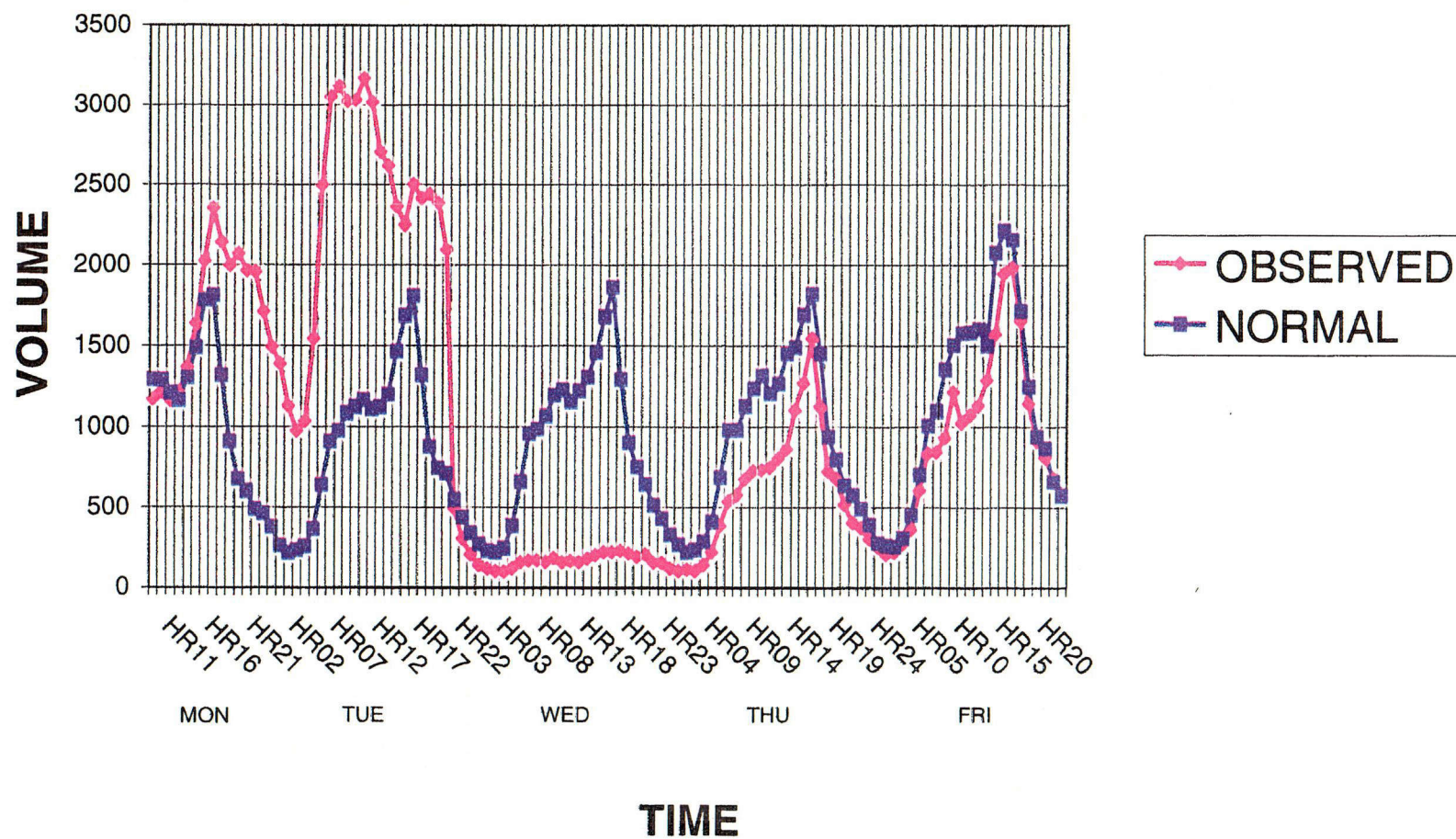
Traffic Count Summaries by State

FLORIDA TRAFFIC COUNTS

WEST BOUND TRAFFIC ON I-10

SITE 109 @CR217 OVERPASS S. OF BALDWIN, DUVAL CO.

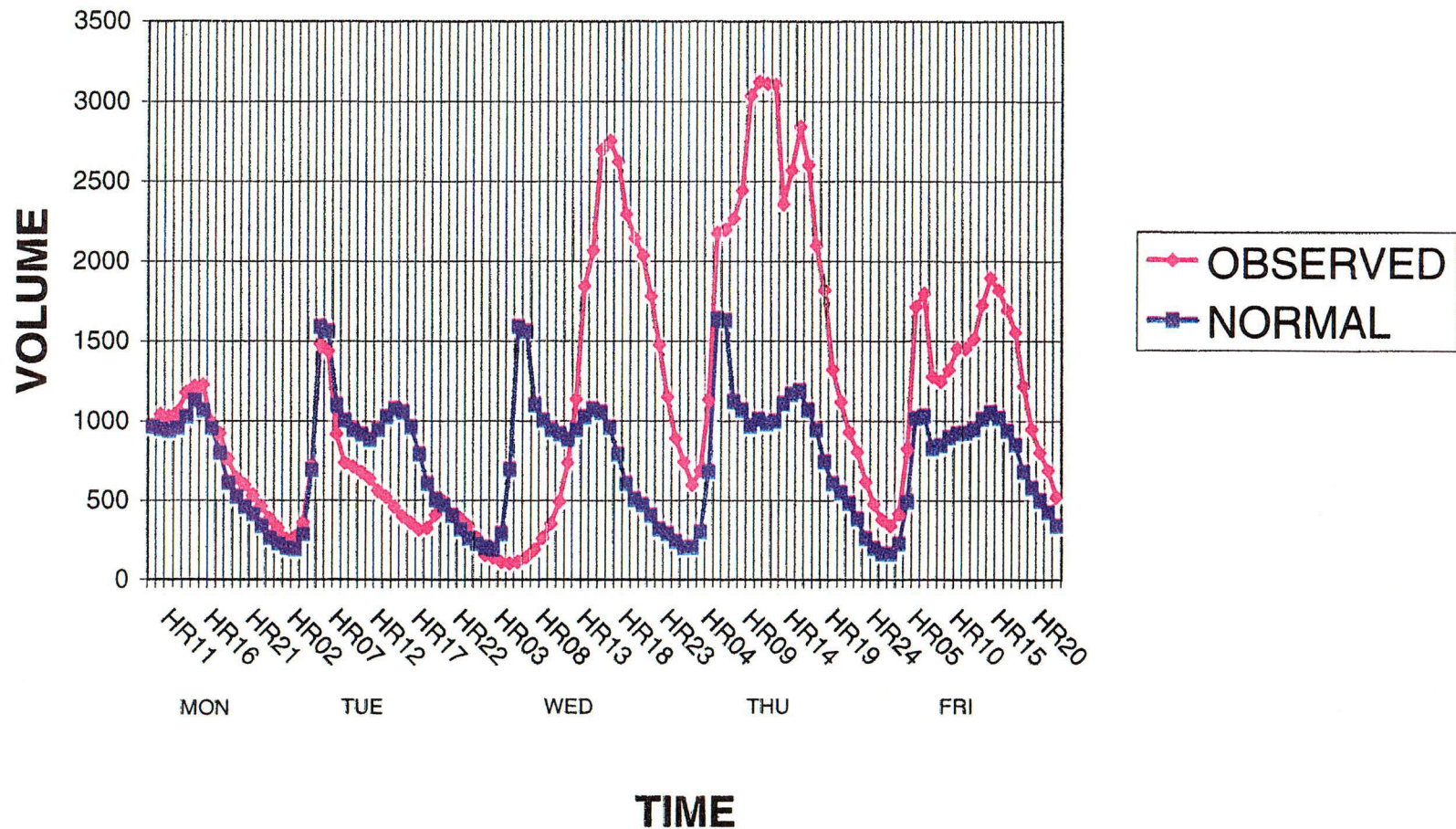
HURRICANE FLOYD (SEPTEMBER 13-17, 1999)



EAST BOUND TRAFFIC ON I-10

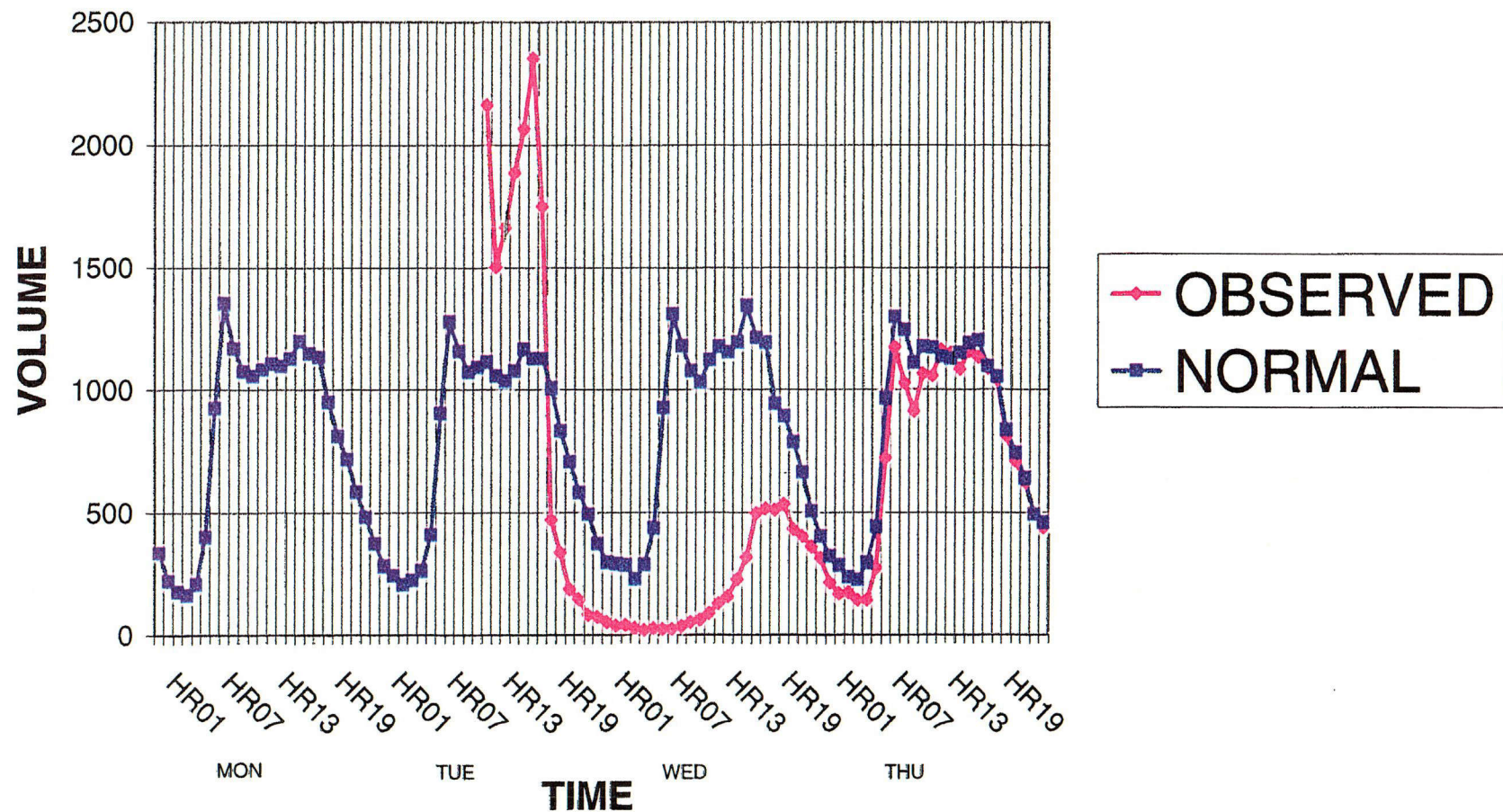
SITE 109 @CR217 OVERPASS S. OF BALDWIN, DUVAL CO.

HURRICANE FLOYD (SEPTEMBER 13-17, 1999)



NORTH BOUND TRAFFIC ON I-95

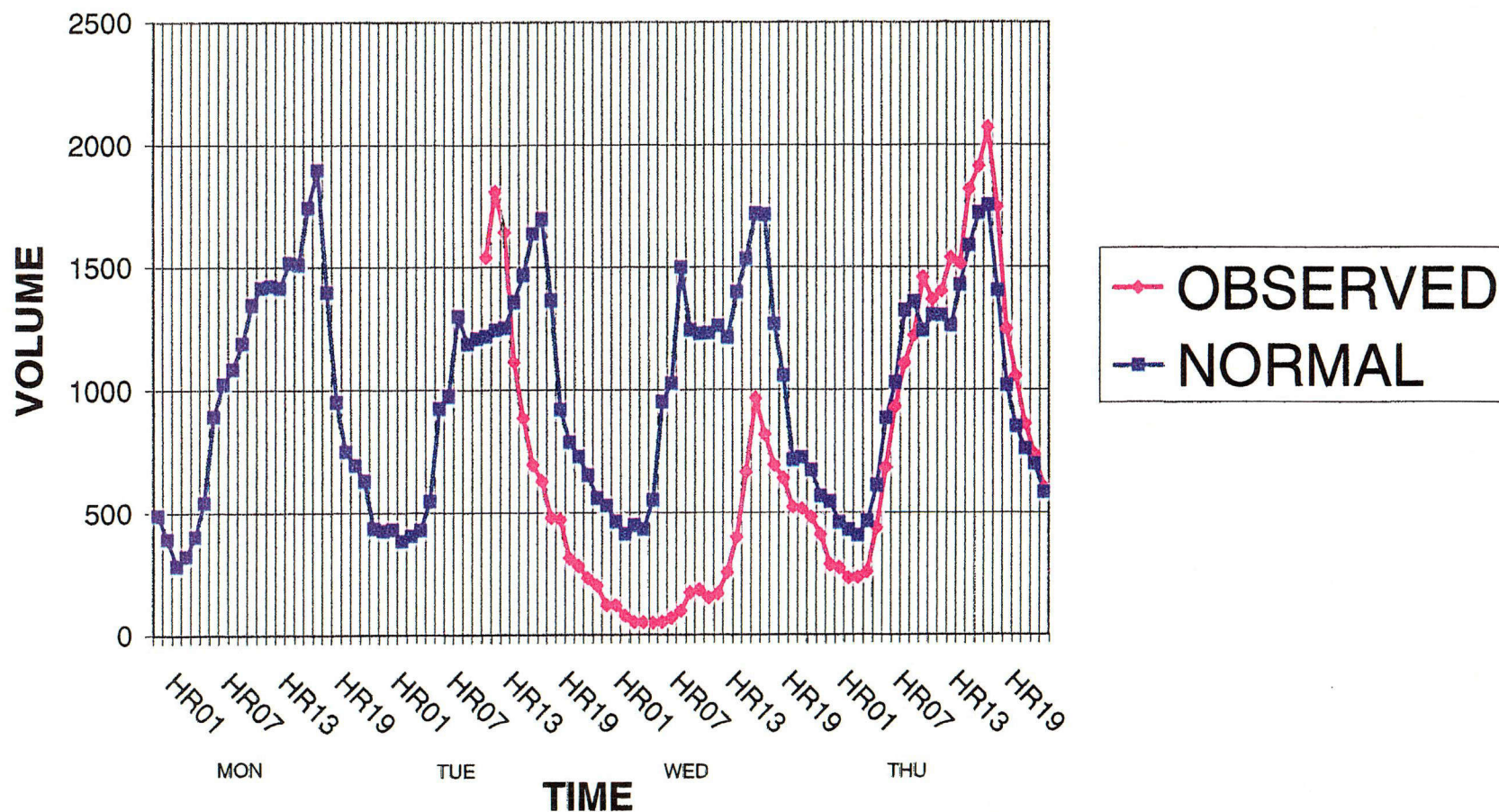
SITE 121 2.0 MI S. OF I-295 S. INT. (S), DUVAL CO.
HURRICANE FLOYD (SEPTEMBER 13-16, 1999)



SOUTH BOUND TRAFFIC ON I-95

SITE 121 2.0 MI S. OF I-295 S. INT. (S), DUVAL CO.

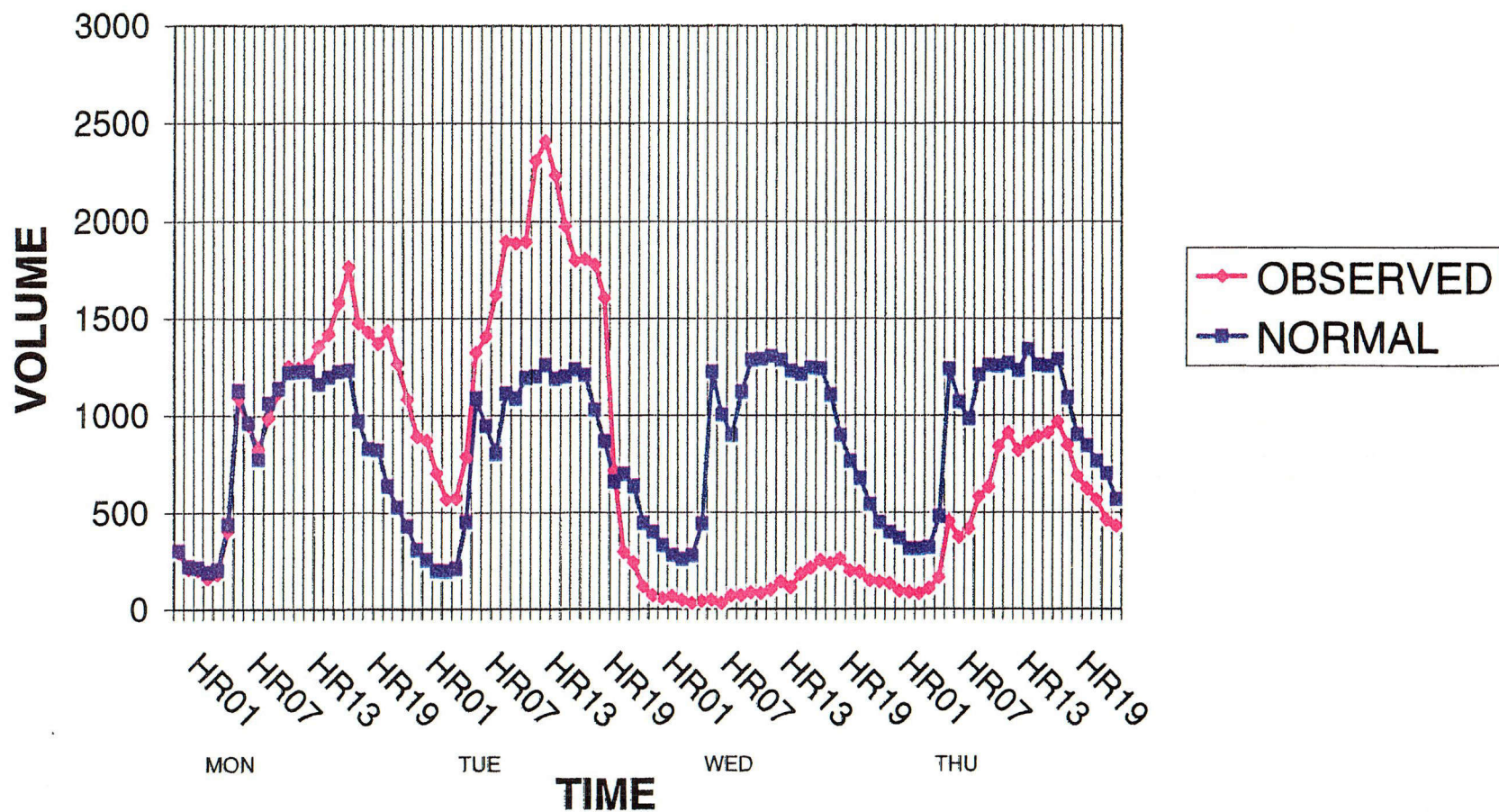
HURRICANE FLOYD (SEPTEMBER 13-16, 1999)



NORTH BOUND TRAFFIC ON I-95

SITE 132 2.0 MI S. OF STATE LINE, NASSAU CO.

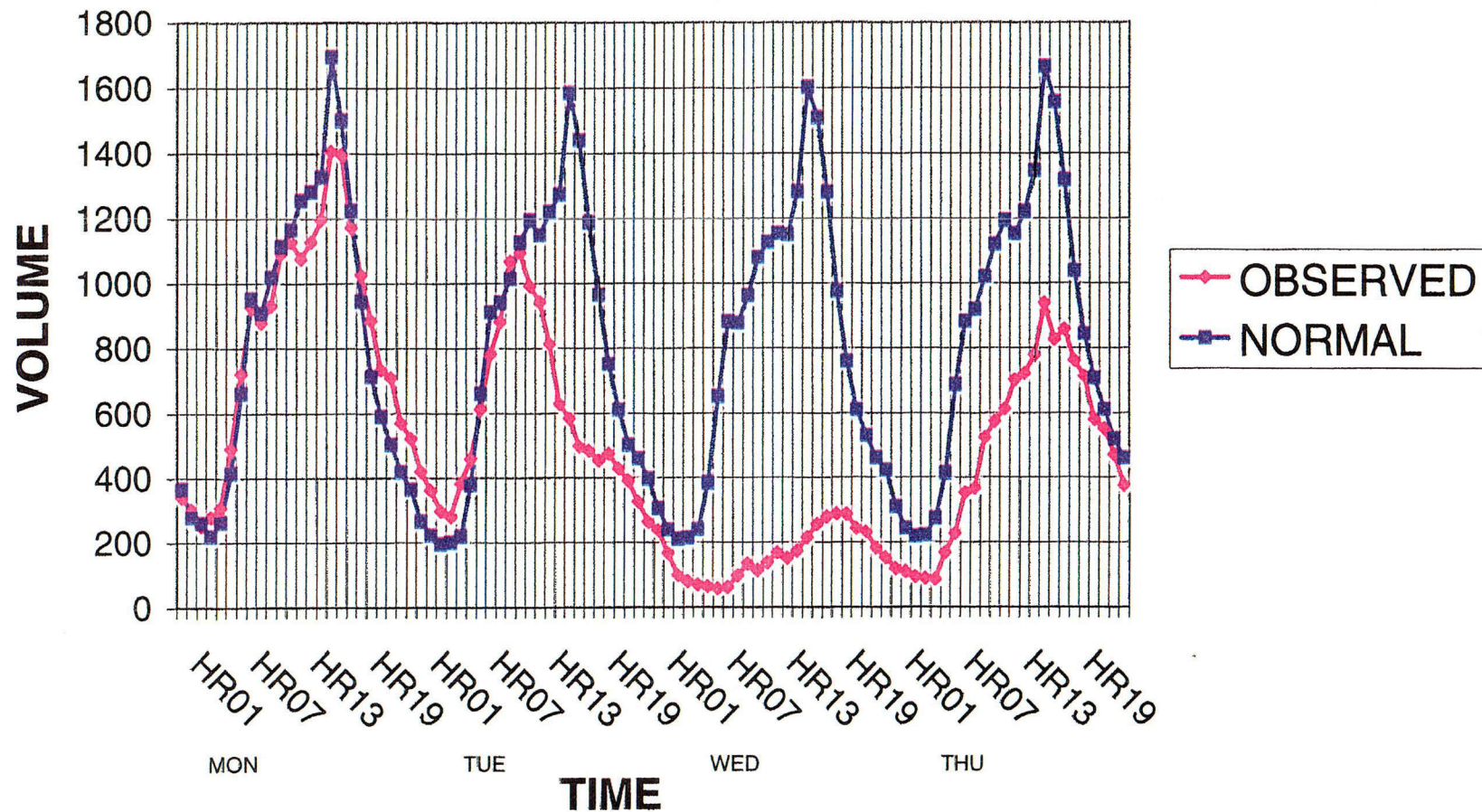
HURRICANE FLOYD (SEPTEMBER 13-16, 1999)



SOUTH BOUND TRAFFIC ON I-95

SITE 132 2.0 MI S. OF STATE LINE, NASSAU CO.

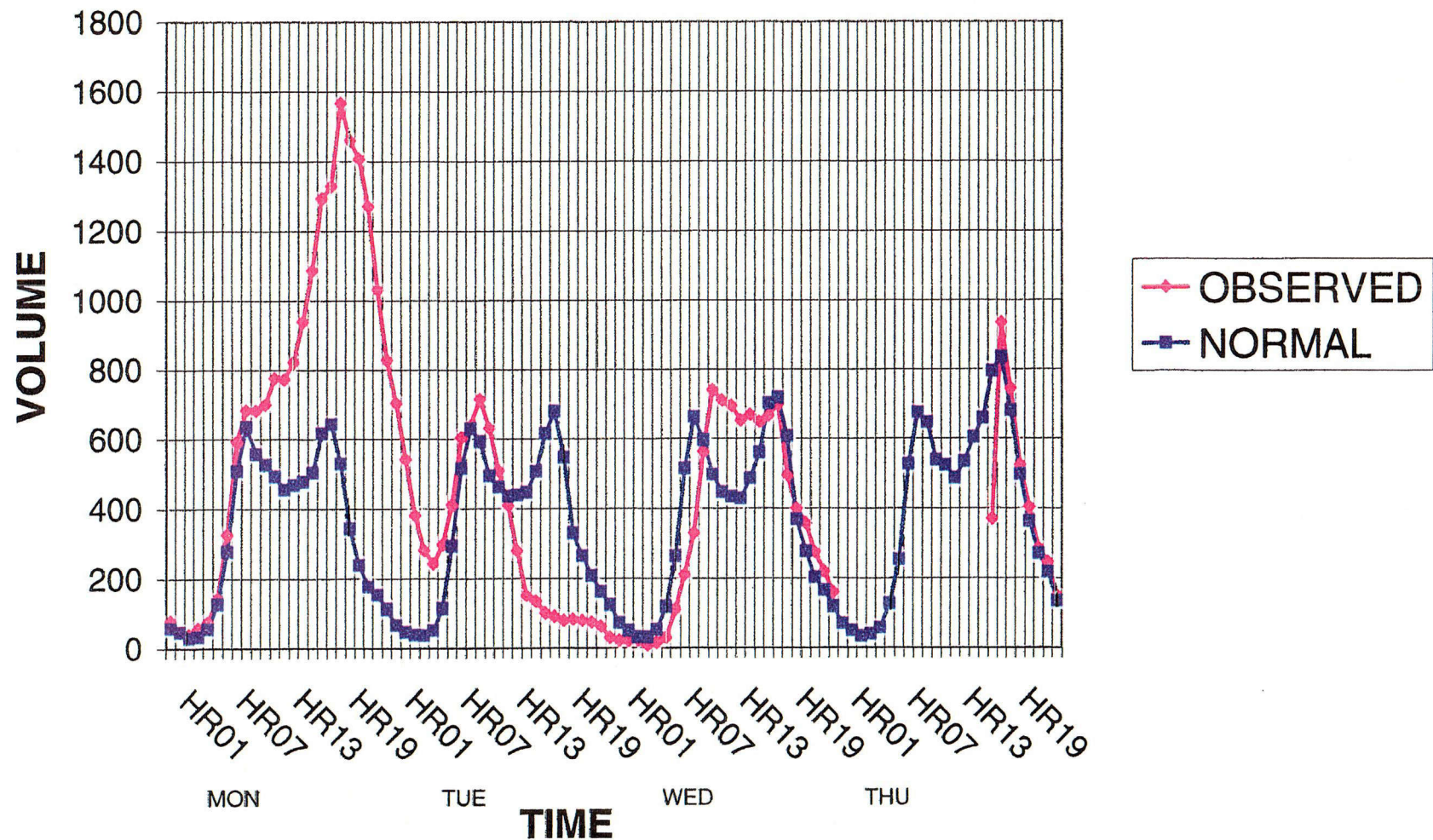
HURRICANE FLOYD (SEPTEMBER 13-16, 1999)



NORTH BOUND TRAFFIC ON TURNPIKE

SITE 417 @ SR-706/INDIANTOWN RD. OVERPASS, PALM BEACH CO.

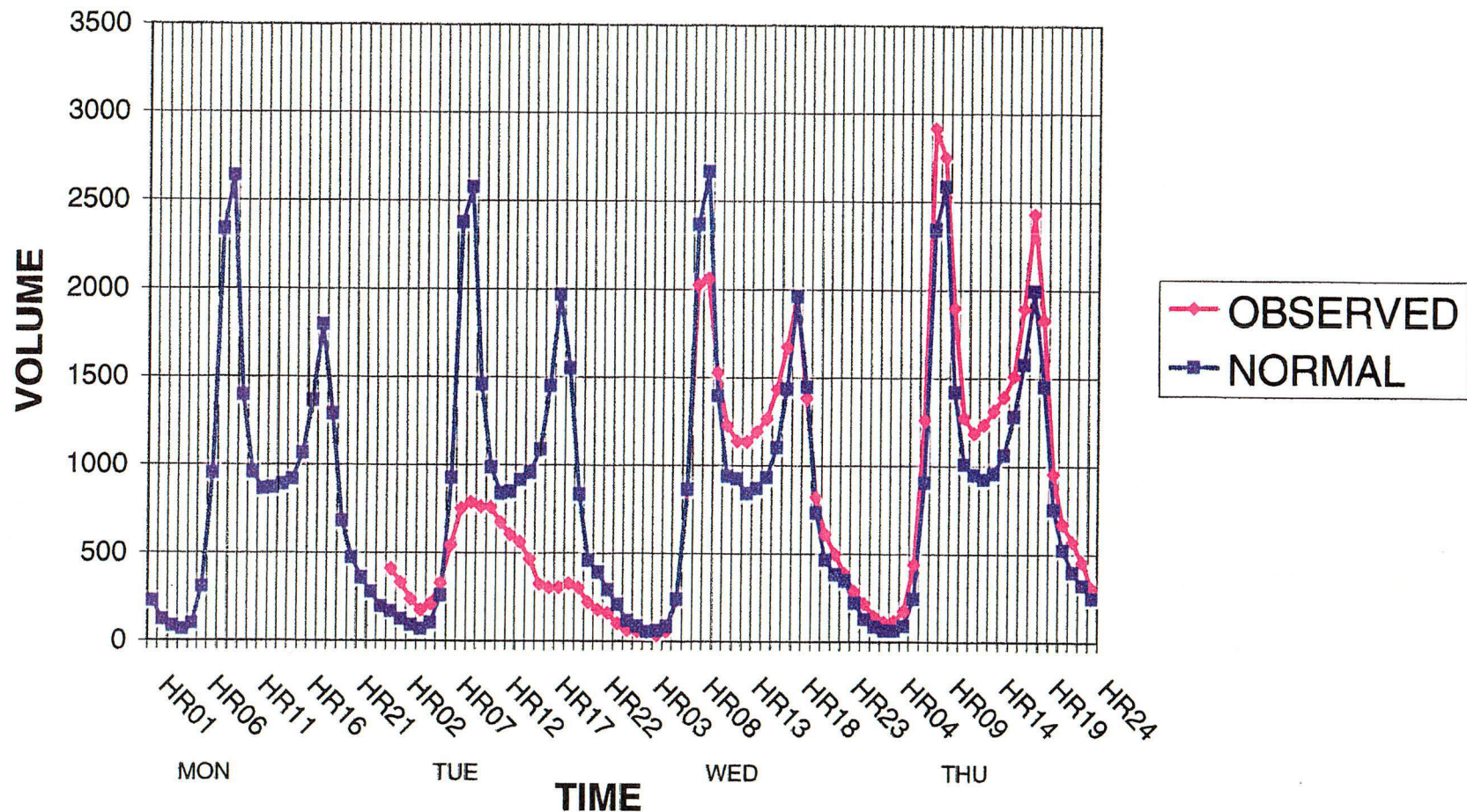
HURRICANE FLOYD (SEPTEMBER 13-16, 1999)



SOUTH BOUND TRAFFIC ON TURNPIKE

SITE 410 1500 FT. N. OF SR-834 (SAMPLE RD.), BROWARD CO.

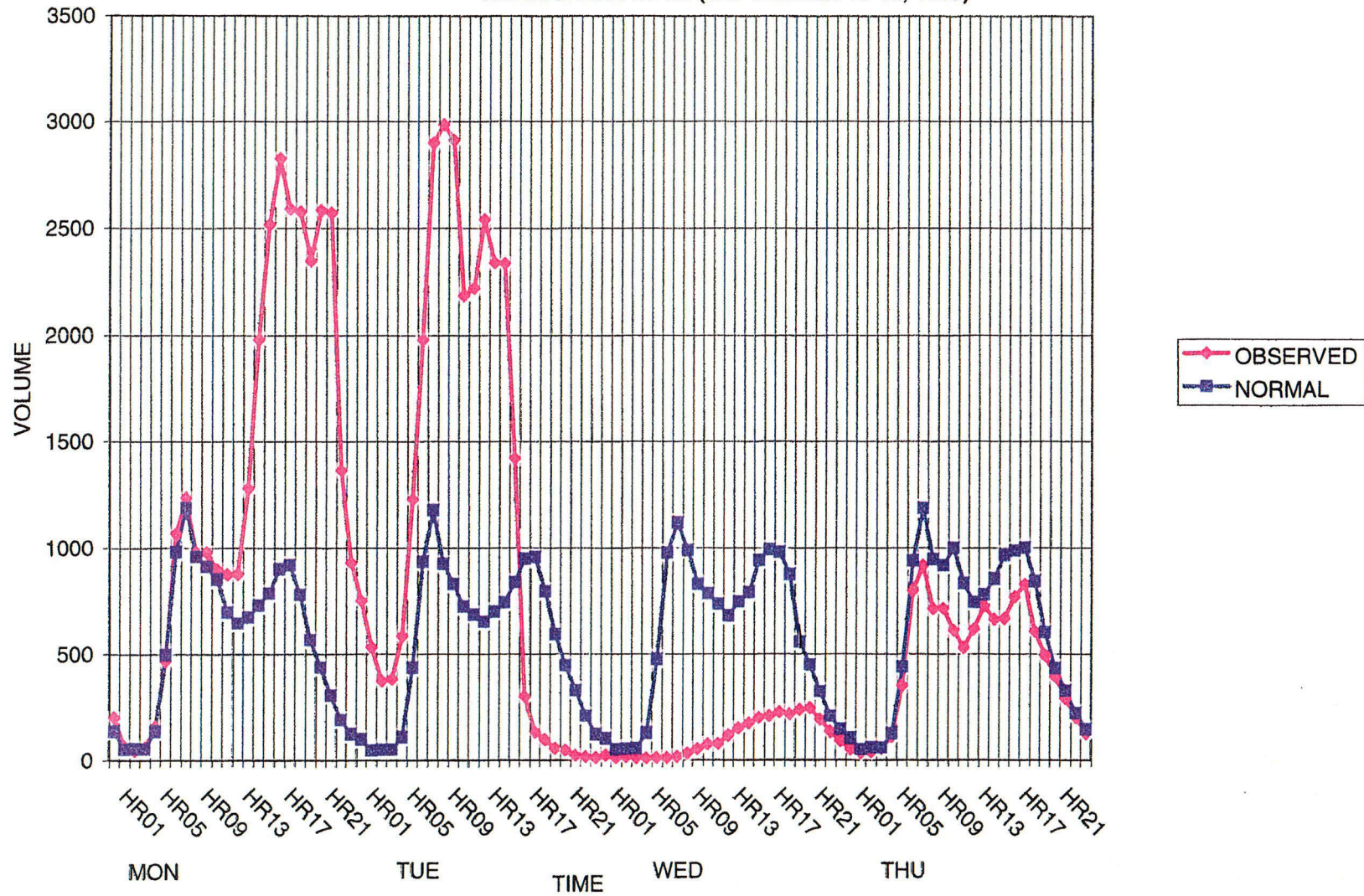
HURRICANE FLOYD (SEPTEMBER 13-16, 1999)



WEST BOUND TRAFFIC ON SR-528

SITE 336 3.1 MI W. OF BREVARD CO. LINE, ORANGE CO.

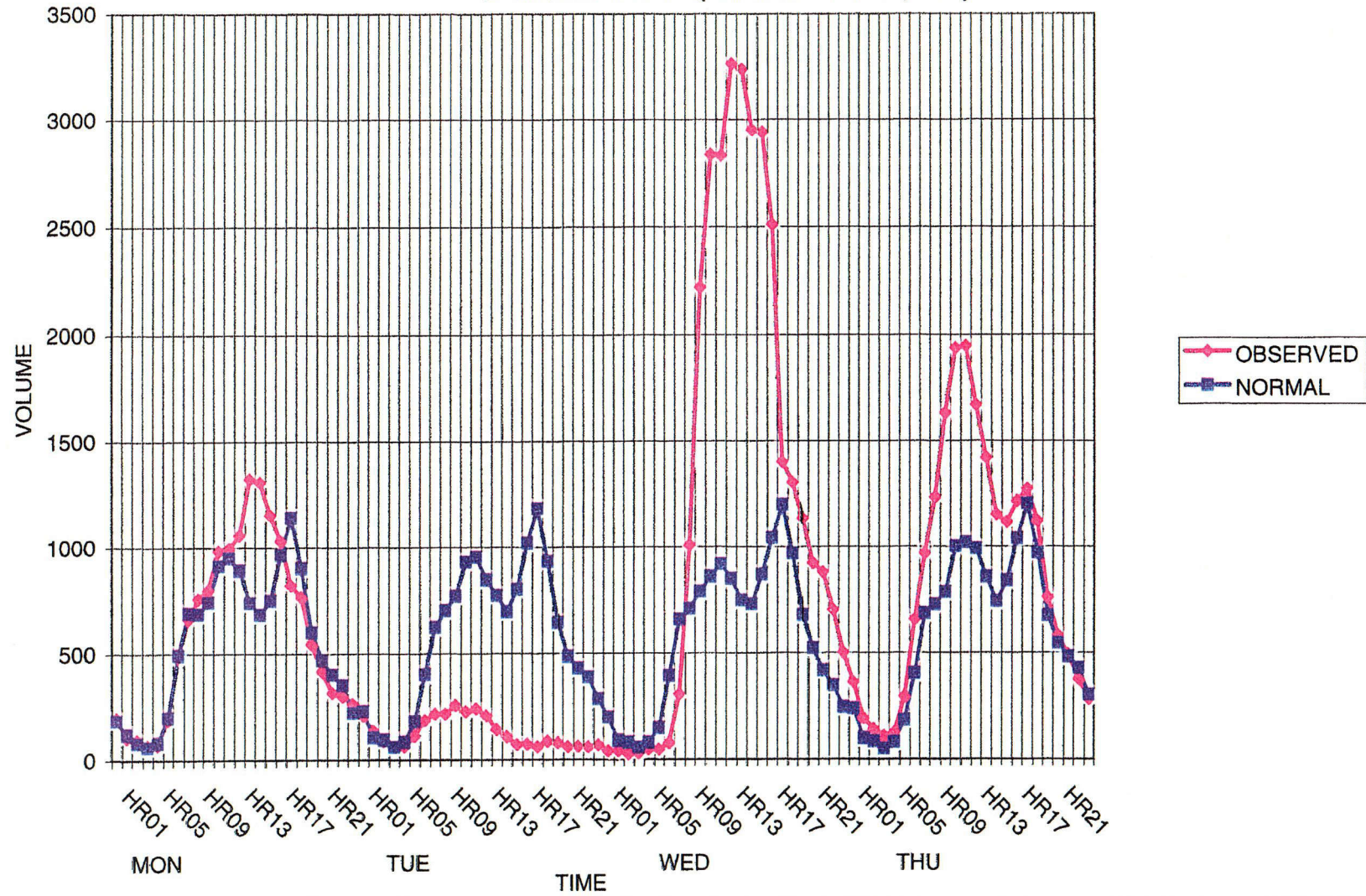
HURRICANE FLOYD (SEPTEMBER 13-16, 1999)



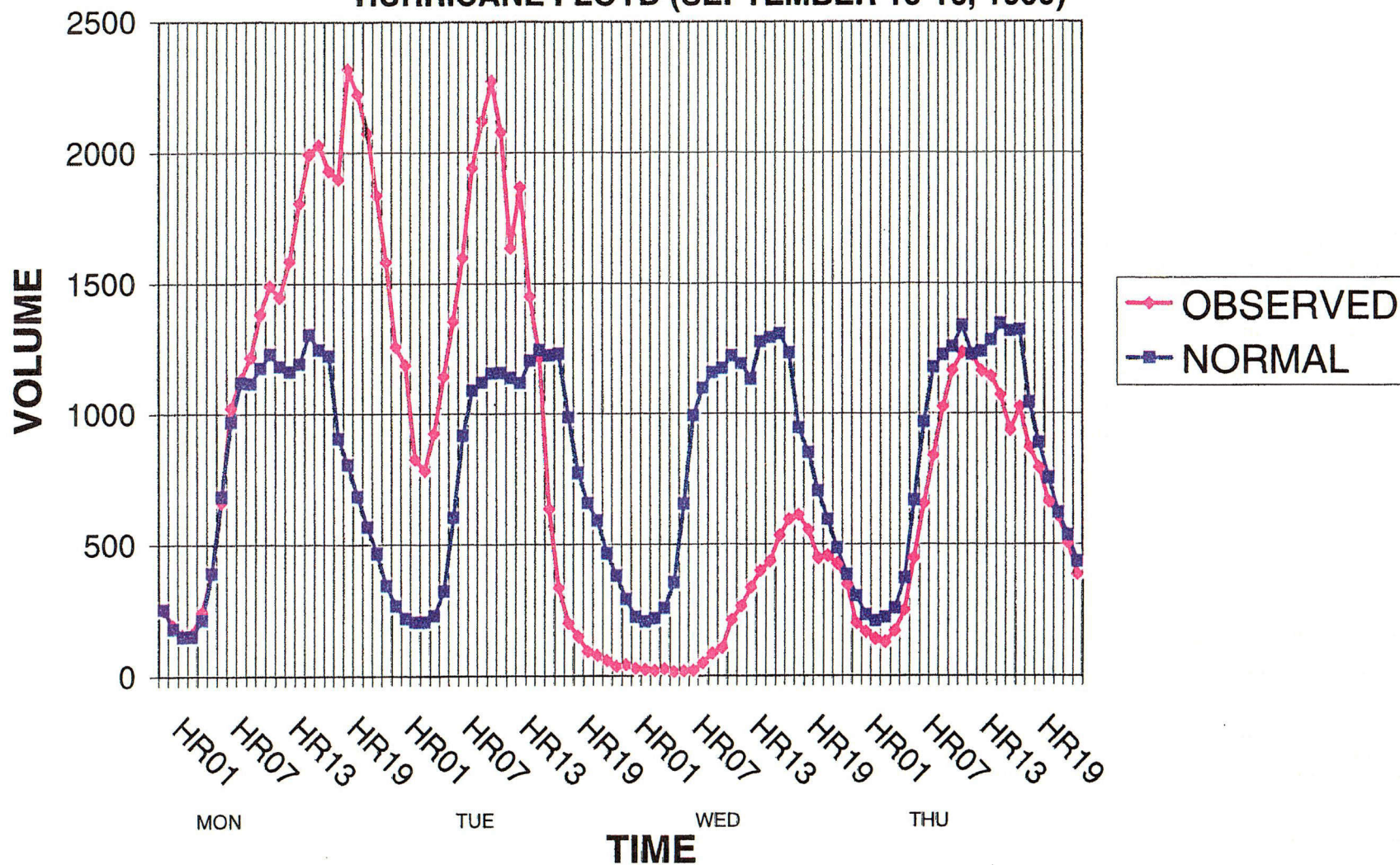
EAST BOUND TRAFFIC ON SR-528

SITE 336 3.1 MI W. OF BREVARD CO. LINE, ORANGE CO.

HURRICANE FLOYD (SEPTEMBER 13-16, 1999)



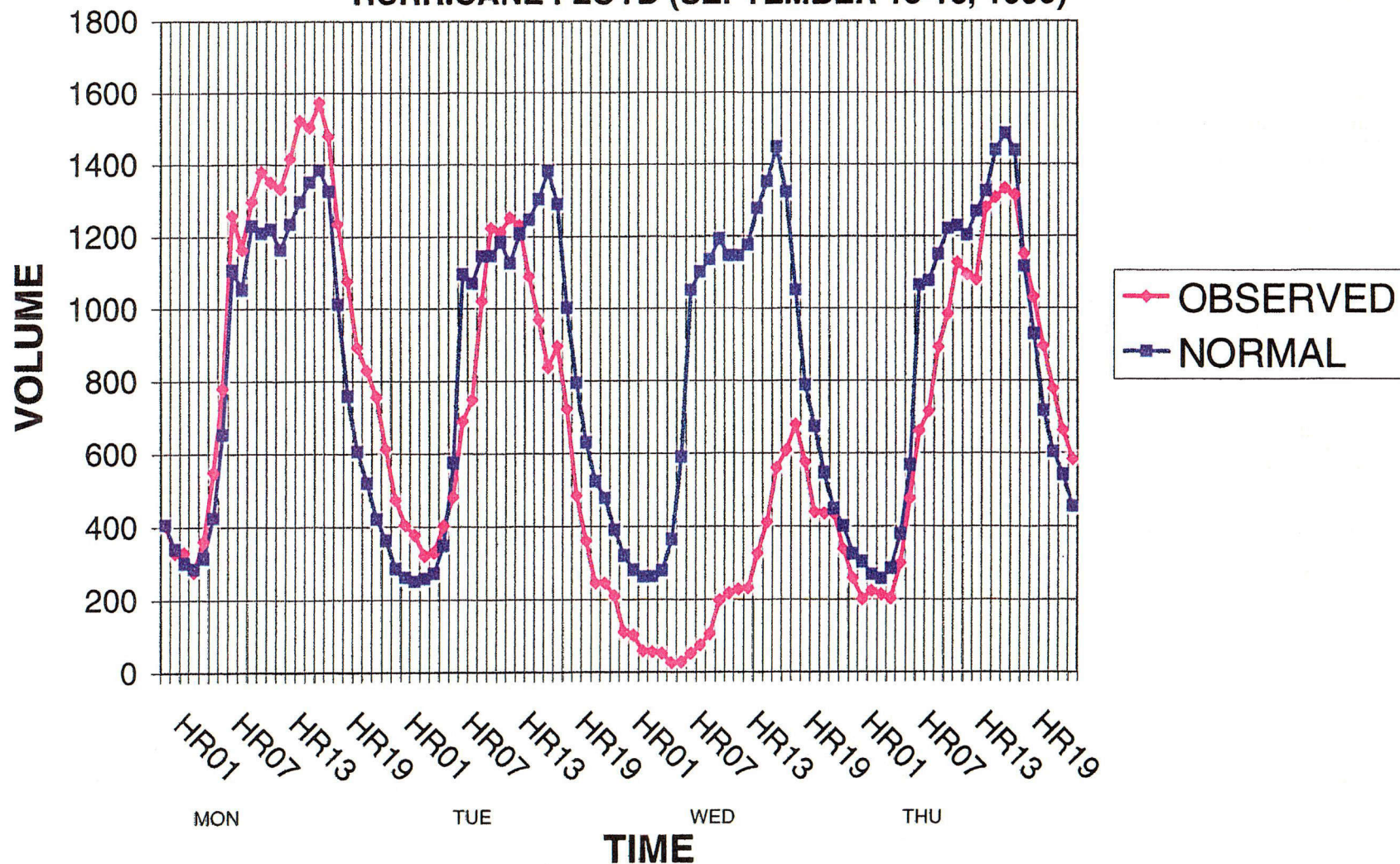
NORTH BOUND TRAFFIC ON I-95
SITE 292 2.0 MI N. OF WEIGH STATION, FLAGLER CO.
HURRICANE FLOYD (SEPTEMBER 13-16, 1999)



SOUTH BOUND TRAFFIC ON I-95

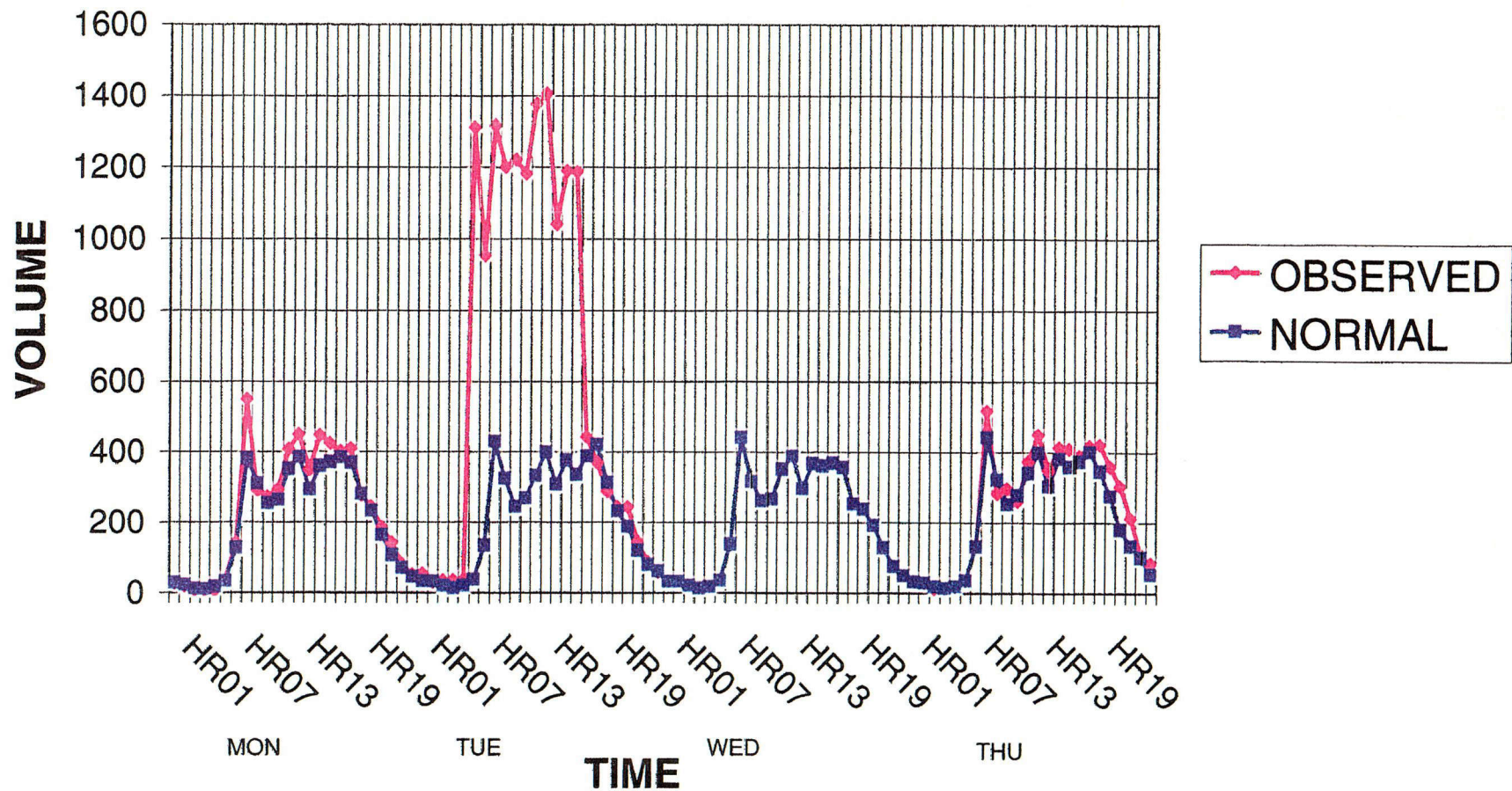
SITE 292 2.0 MI N. OF WEIGH STATION, FLAGLER CO.

HURRICANE FLOYD (SEPTEMBER 13-16, 1999)



WEST BOUND TRAFFIC ON US-90

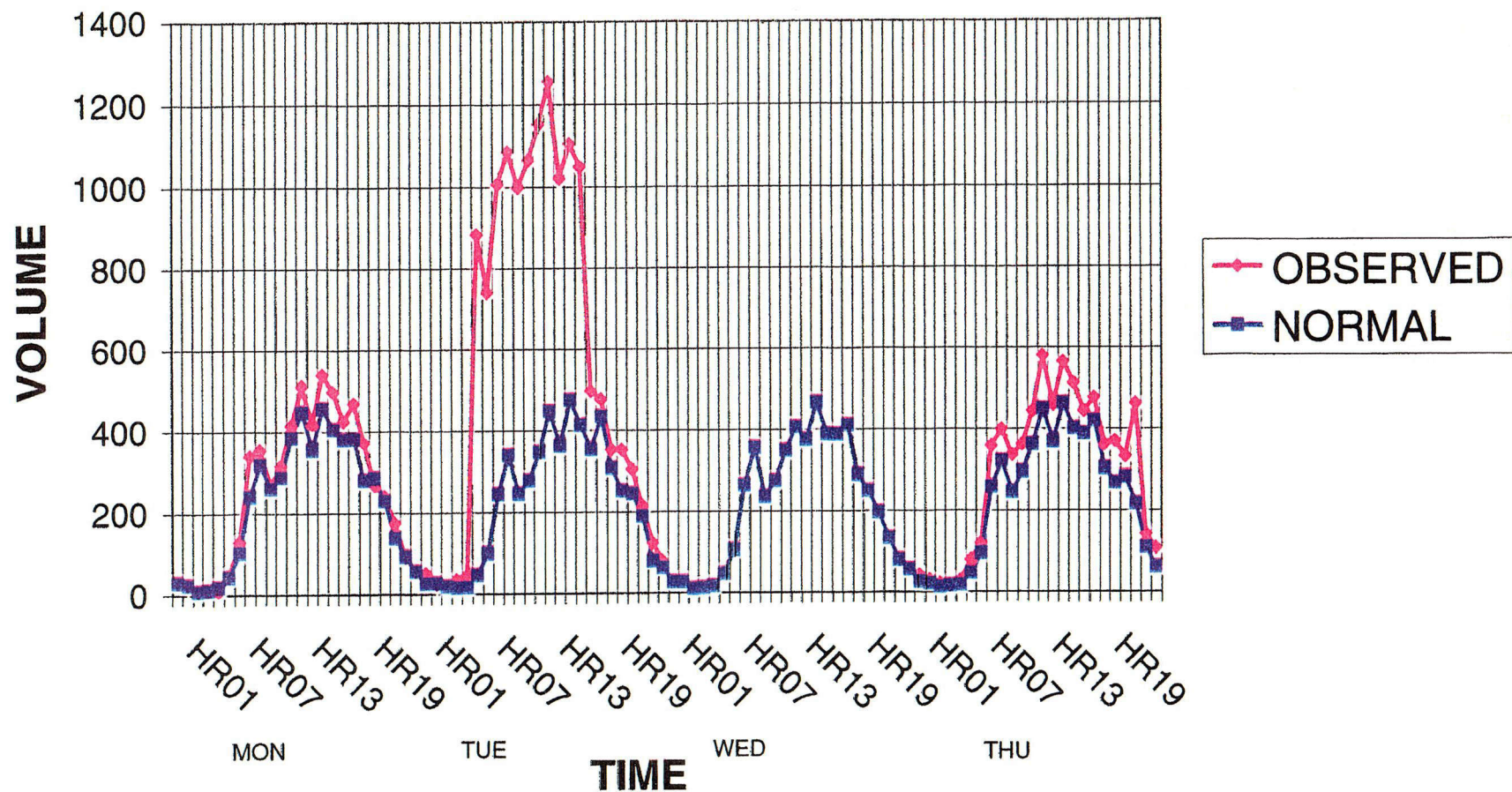
SITE 279 47 FT. E. OF SUMANTRA DRIVE, MADISON CO.
HURRICANE FLOYD (SEPTEMBER 13-16, 1999)



EAST BOUND TRAFFIC ON US-90

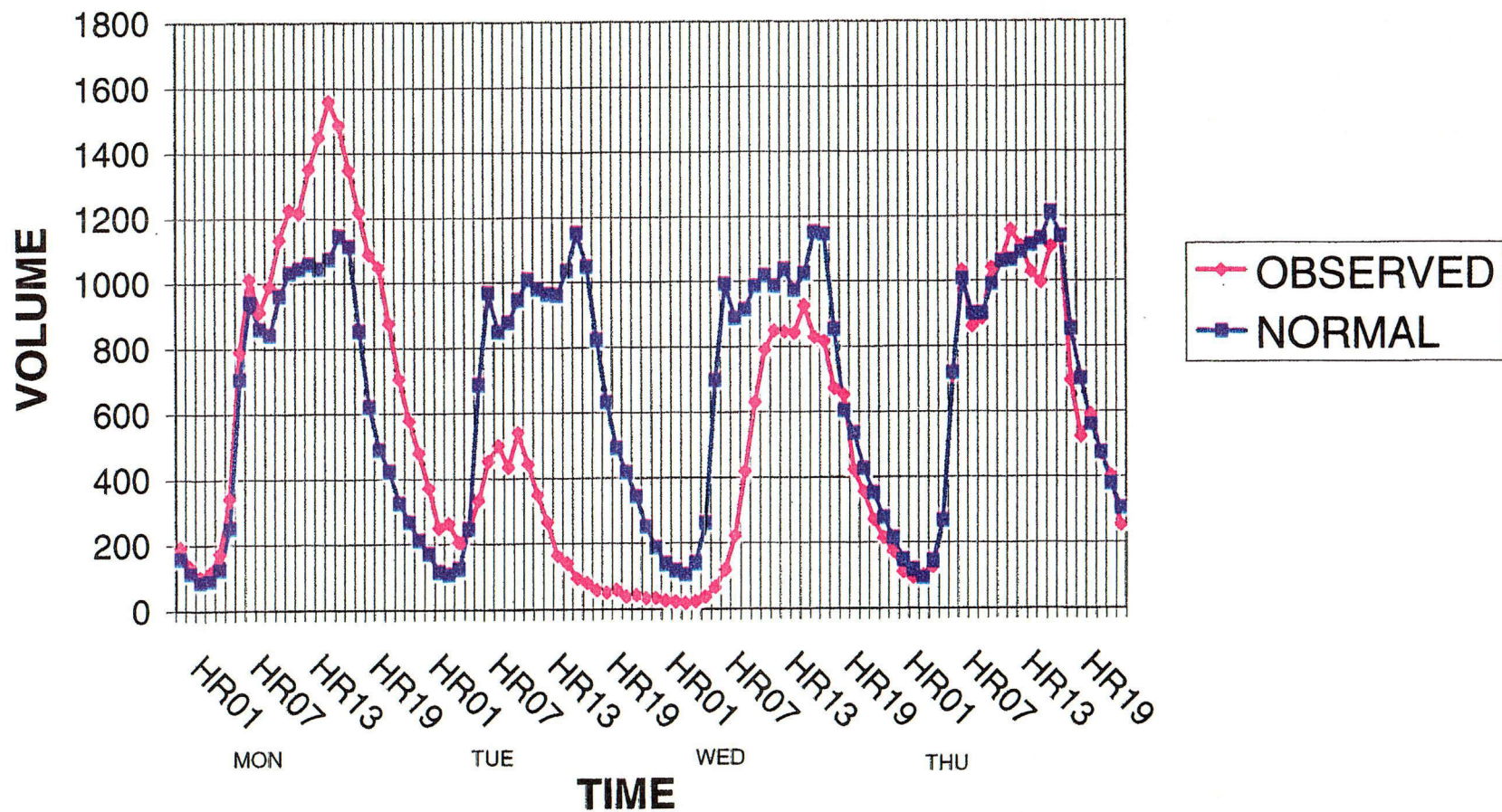
SITE 279 47 FT. E. OF SUMANTRA DRIVE, MADISON CO.

HURRICANE FLOYD (SEPTEMBER 13-16, 1999)



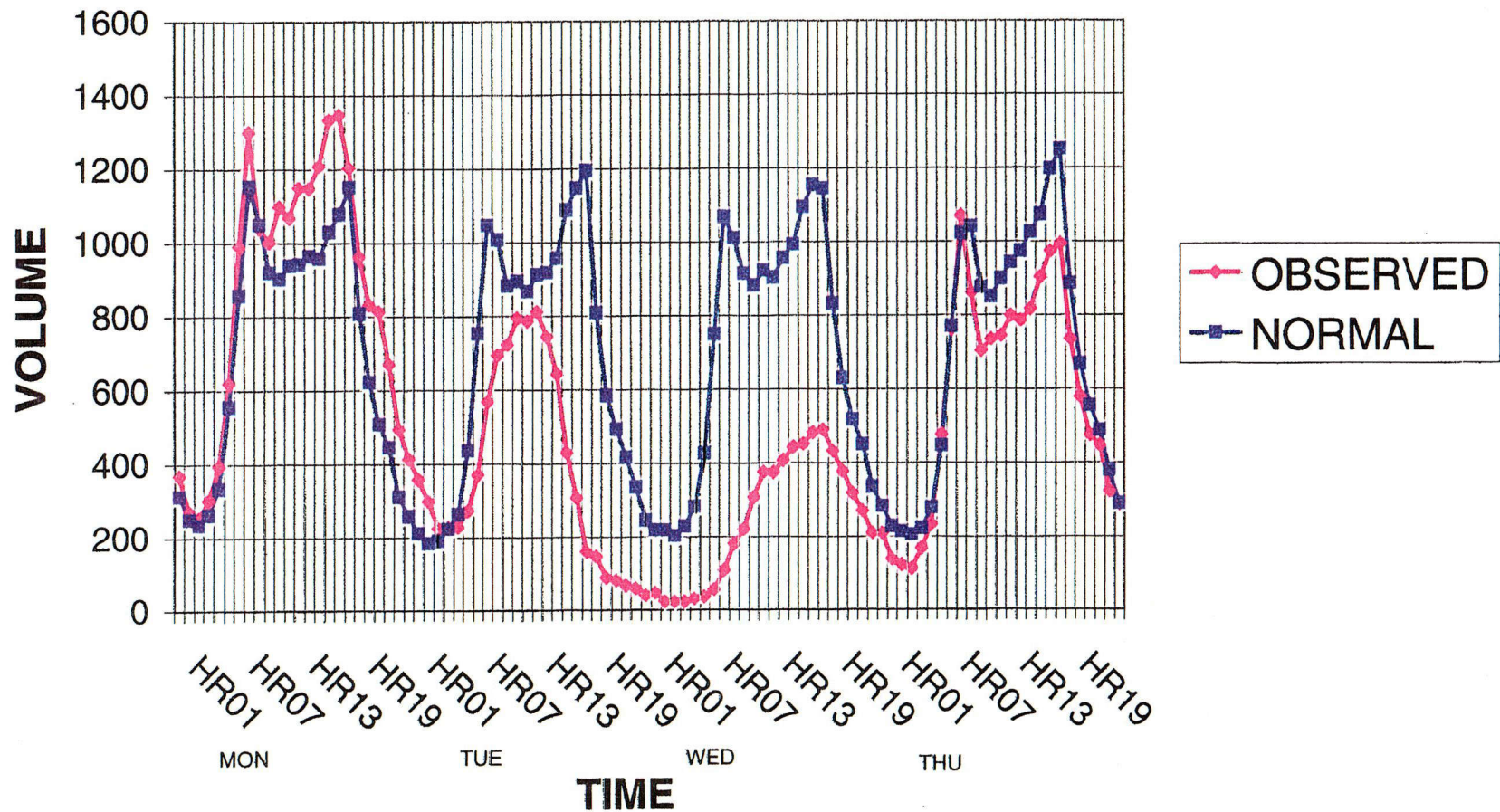
NORTH BOUND TRAFFIC ON I-95

SITE 260 .6 MI S. OF SR-68, ST. LUCIE CO.
HURRICANE FLOYD (SEPTEMBER 13-16, 1999)



SOUTH BOUND TRAFFIC ON I-95

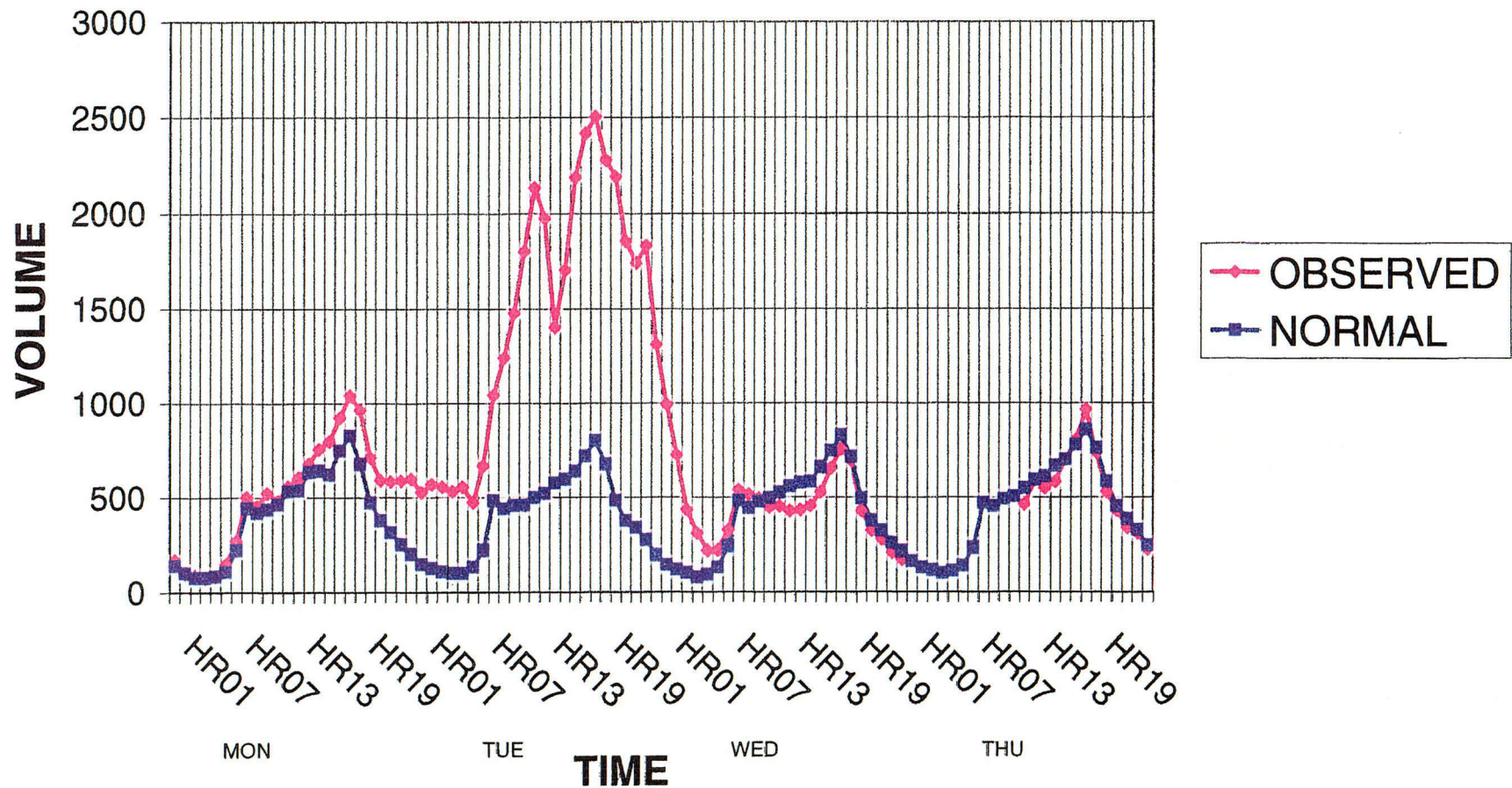
SITE 260 .6 MI S. OF SR-68, ST. LUCIE CO.
HURRICANE FLOYD (SEPTEMBER 13-16, 1999)



WEST BOUND TRAFFIC ON I-10

SITE 220 250 FT. W. OF CR-268 OVERPASS, GADSDEN CO.

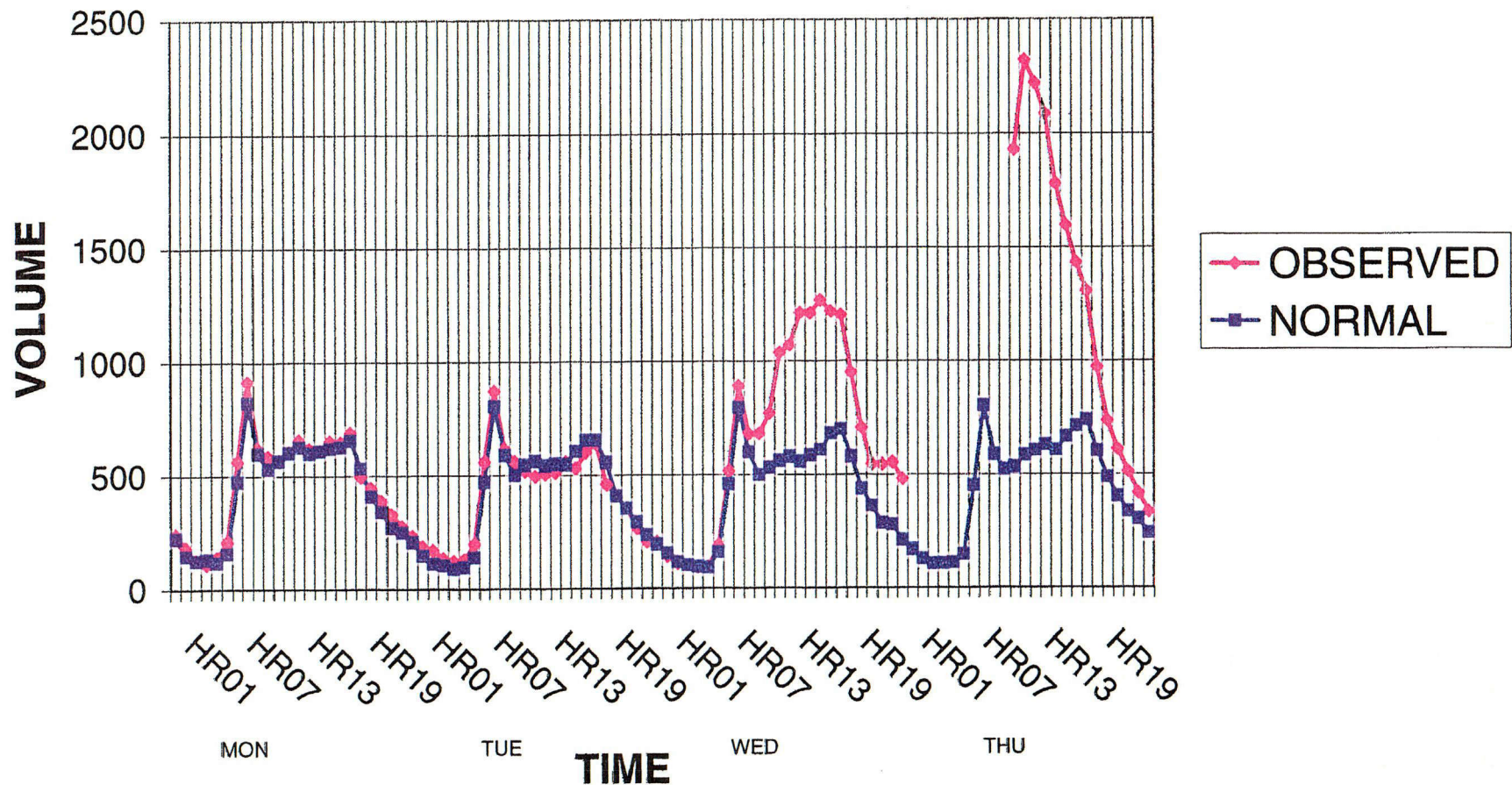
HURRICANE FLOYD (SEPTEMBER 13-16, 1999)



EAST BOUND TRAFFIC ON I-10

SITE 220 250 FT. W. OF CR-268 OVERPASS, GADSDEN CO.

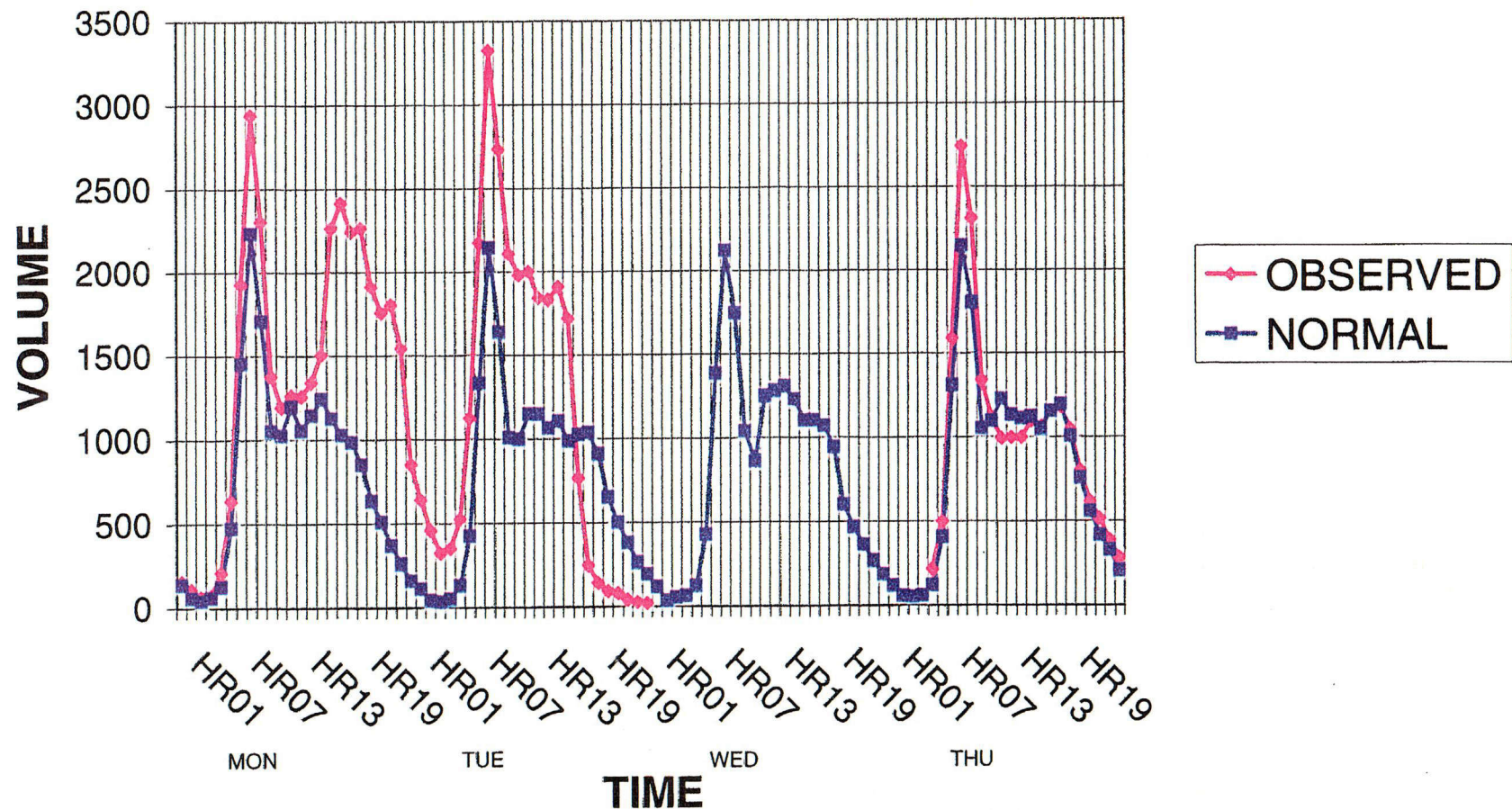
HURRICANE FLOYD (SEPTEMBER 13-16, 1999)



WEST BOUND TRAFFIC ON SR-528

SITE 204 BEELINE EXPWY .8 MI W. OF SR-15, ORANGE CO.

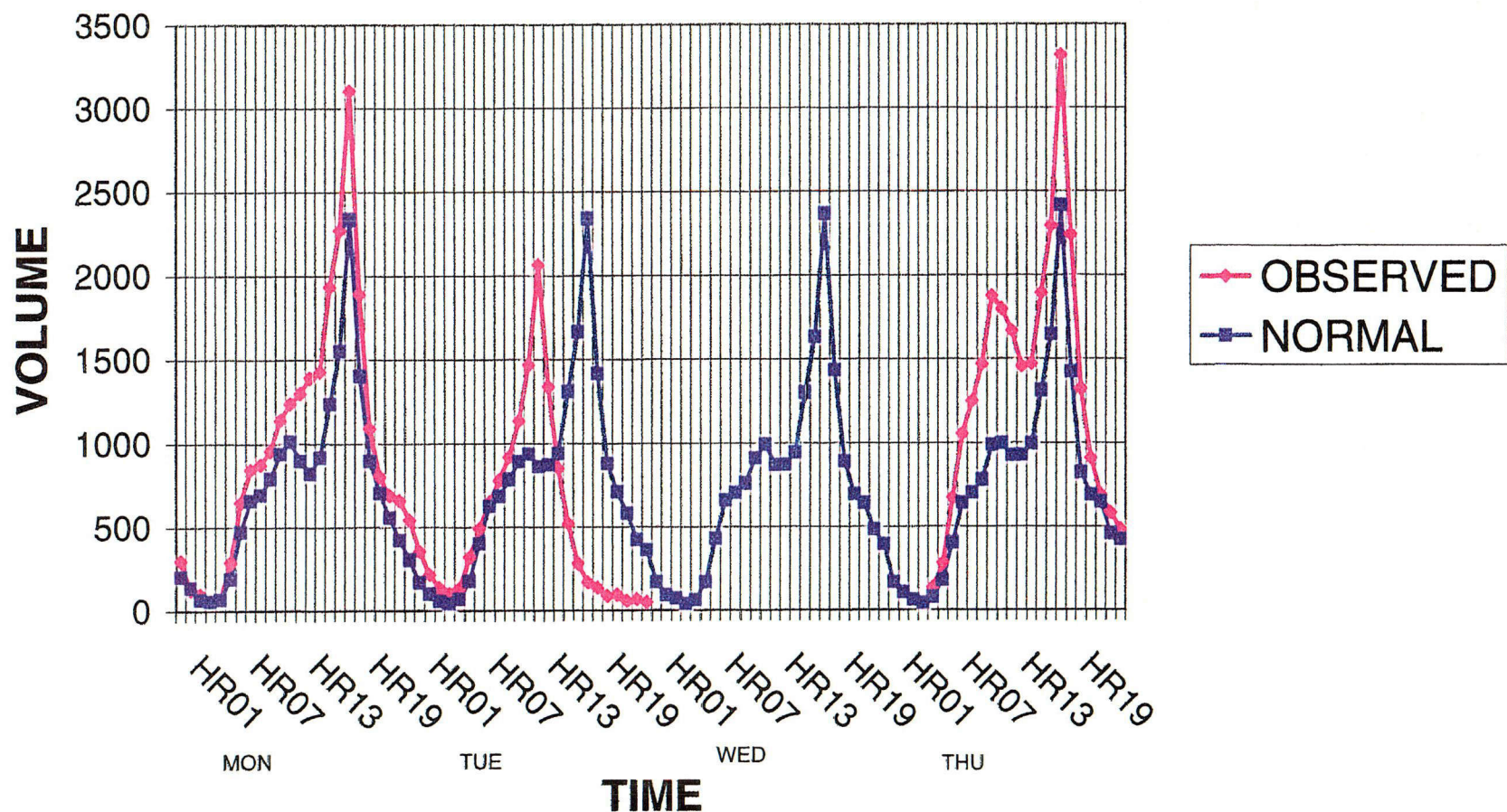
HURRICANE FLOYD (SEPTEMBER 13-16, 1999)



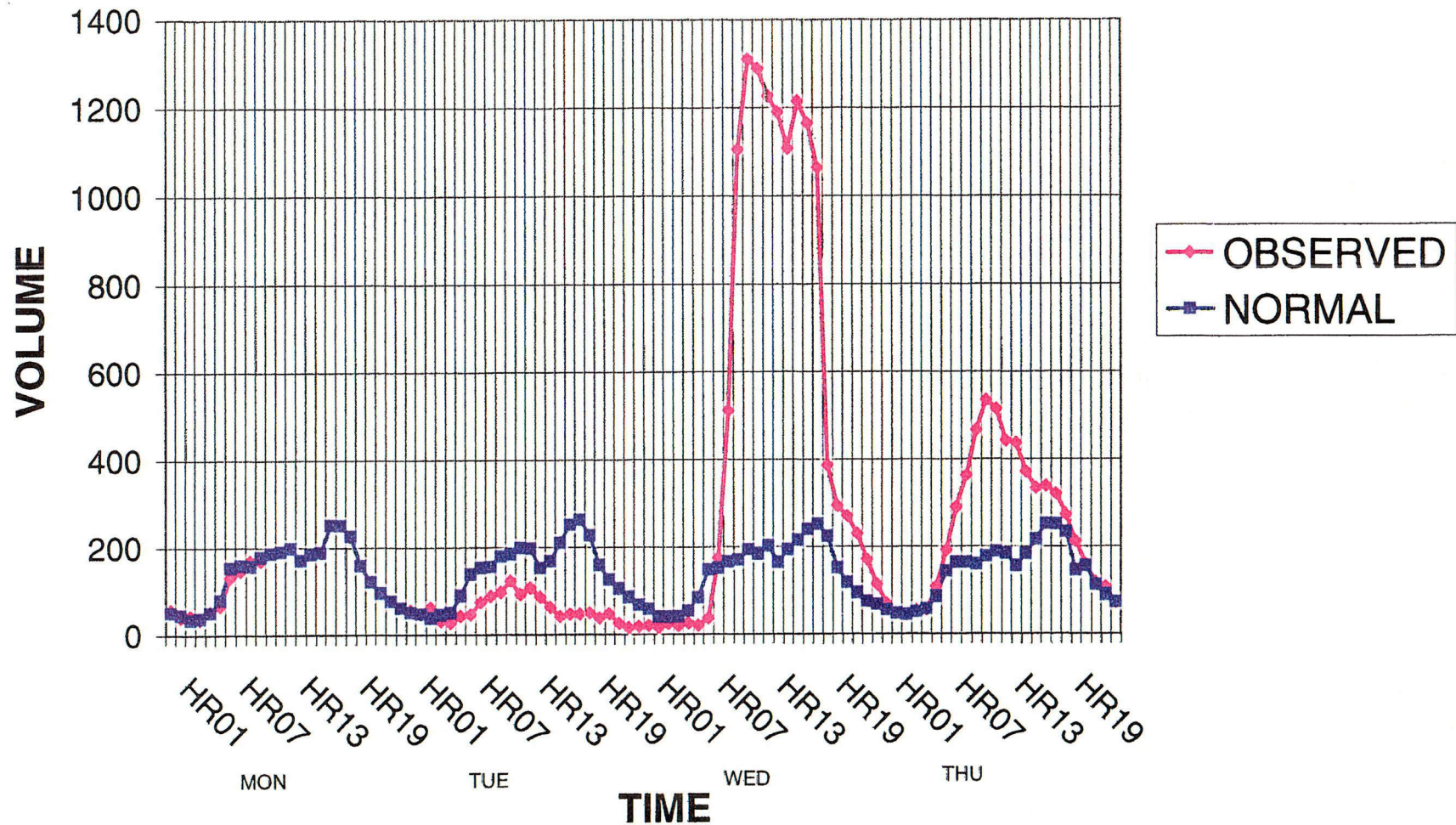
EAST BOUND TRAFFIC ON SR-528

SITE 204 BEELINE EXPWY .8 MI W. OF SR-15, ORANGE CO.

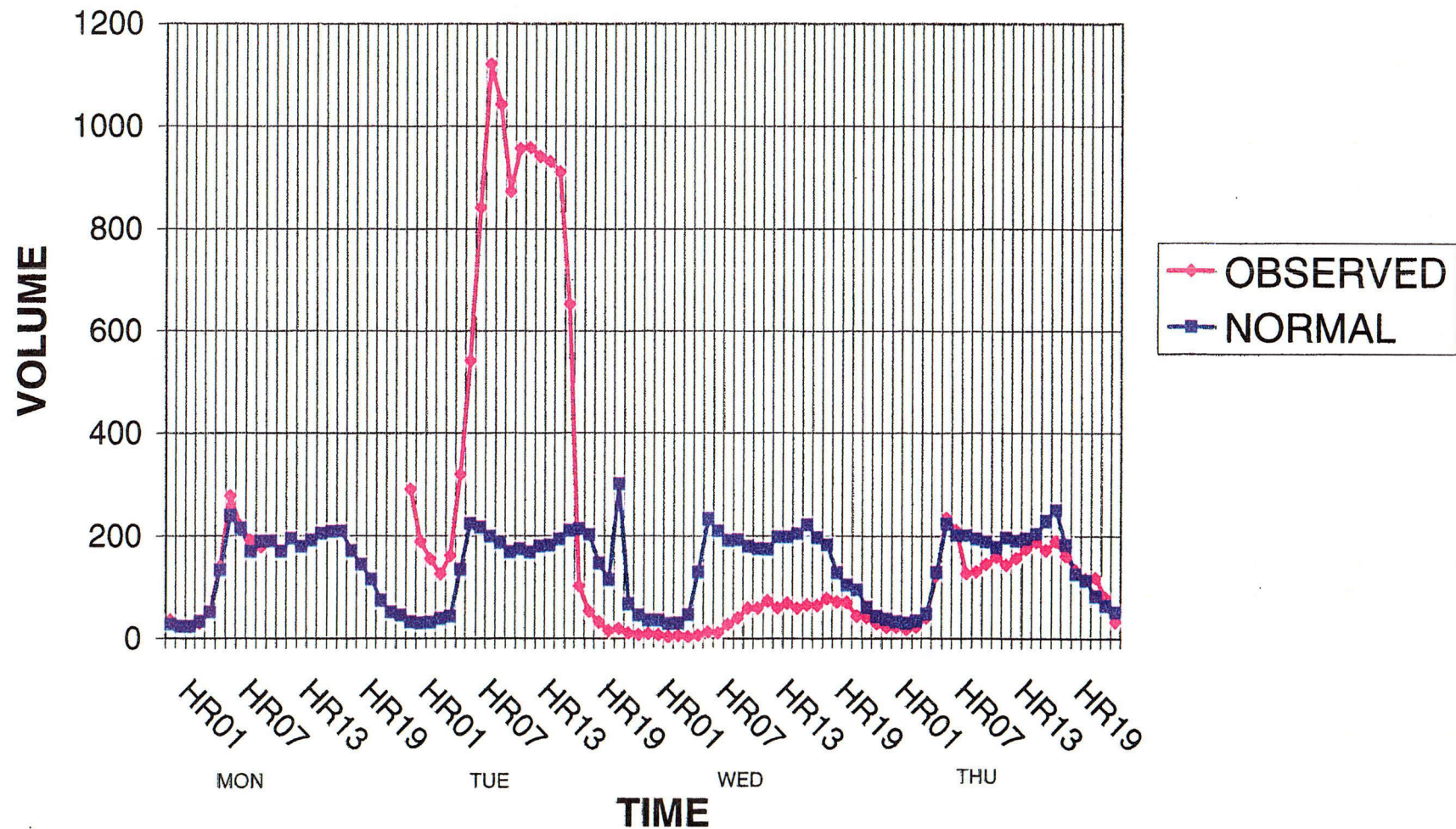
HURRICANE FLOYD (SEPTEMBER 13-16, 1999)



EAST BOUND TRAFFIC ON SR-500
SITE 65 2.0 MI W. OF SR-15 IN HOLOPAW, OSCEOLA CO.
HURRICANE FLOYD (SEPTEMBER 13-19, 1999)

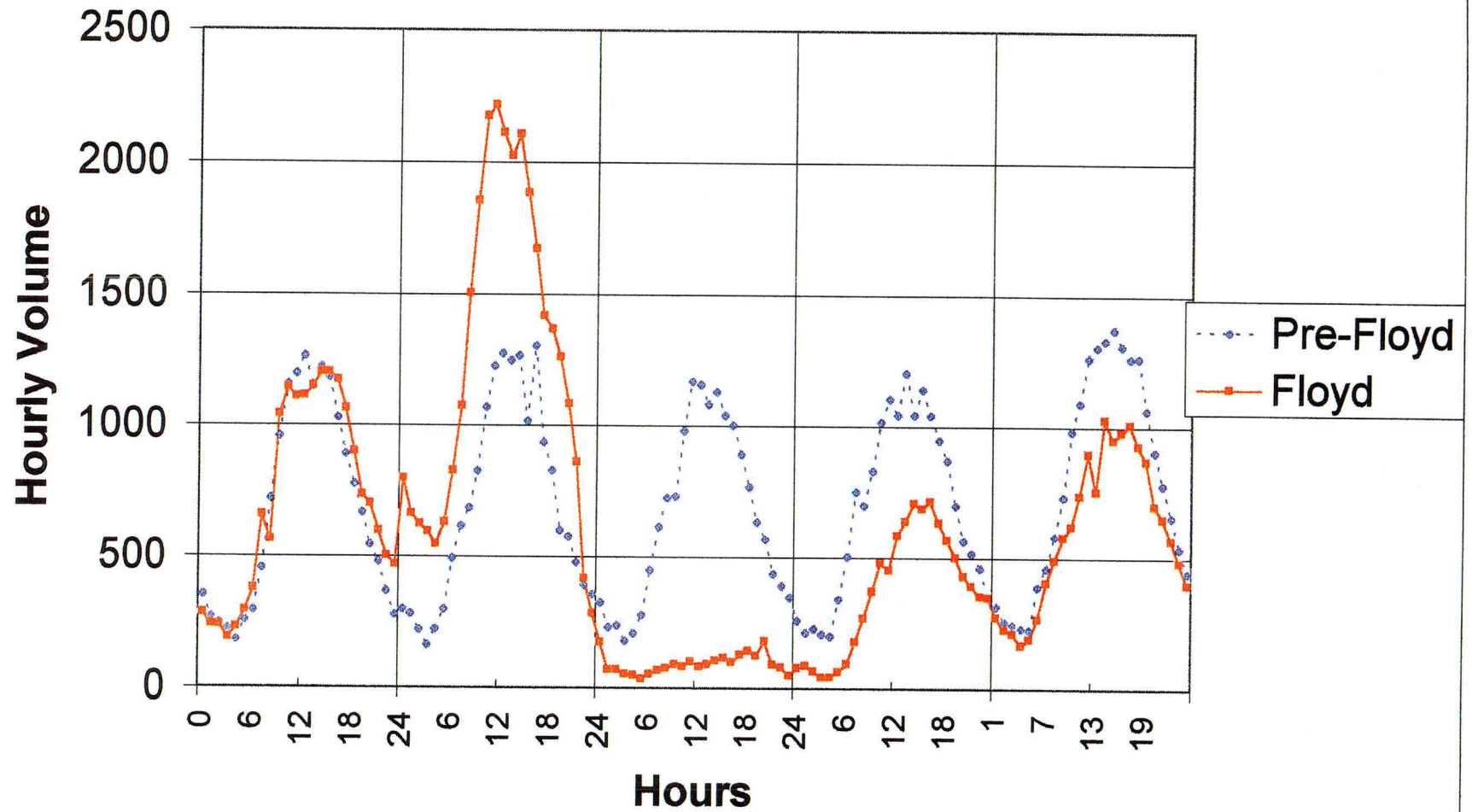


WEST BOUND TRAFFIC ON SR-500
SITE 65 2.0 MI W. OF SR-15 IN HOLOPAW, OSCEOLA CO.
HURRICANE FLOYD (SEPTEMBER 13-19, 1999)

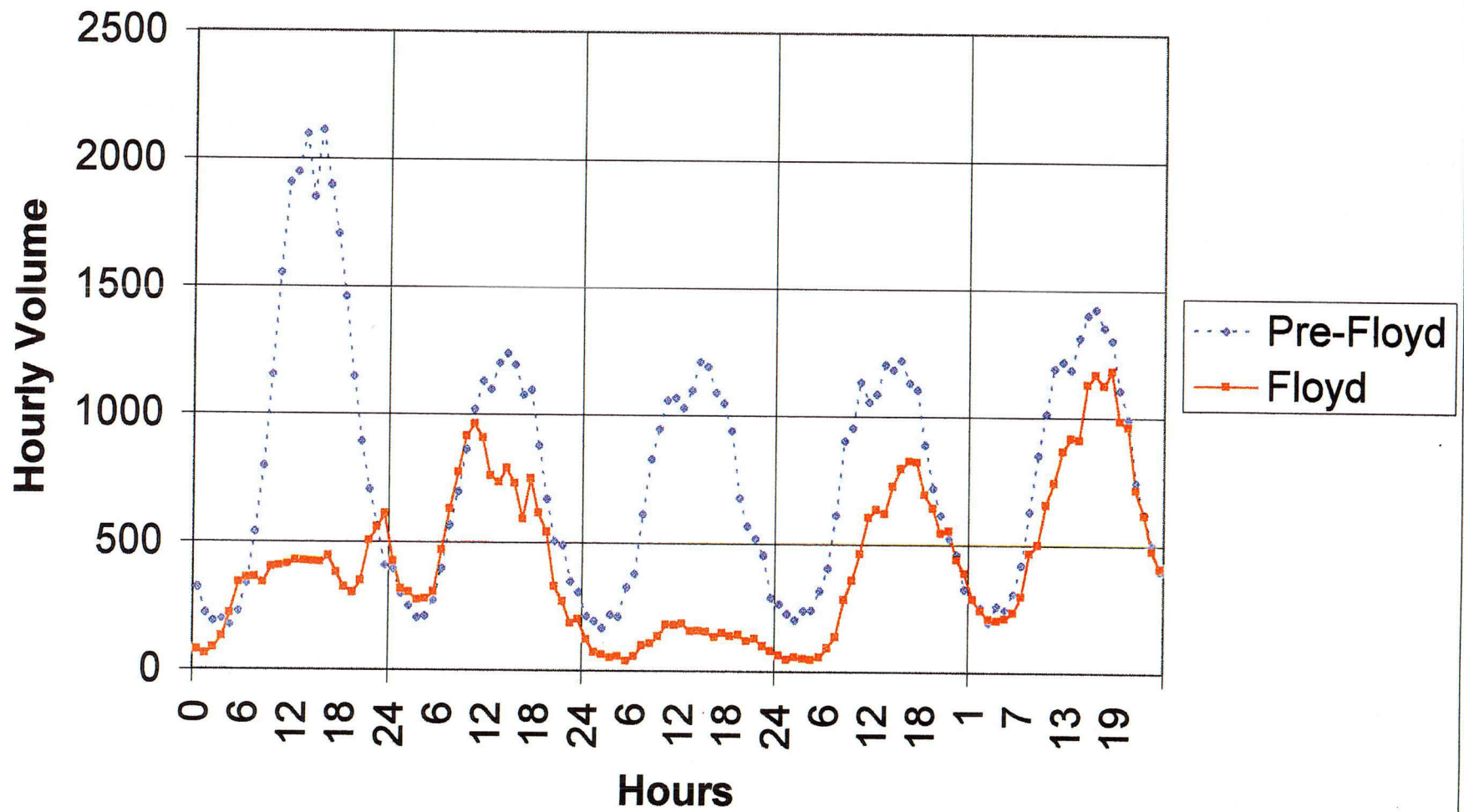


GEORGIA TRAFFIC COUNTS

I-95 Northbound at Midway (Mon.-Fri.)



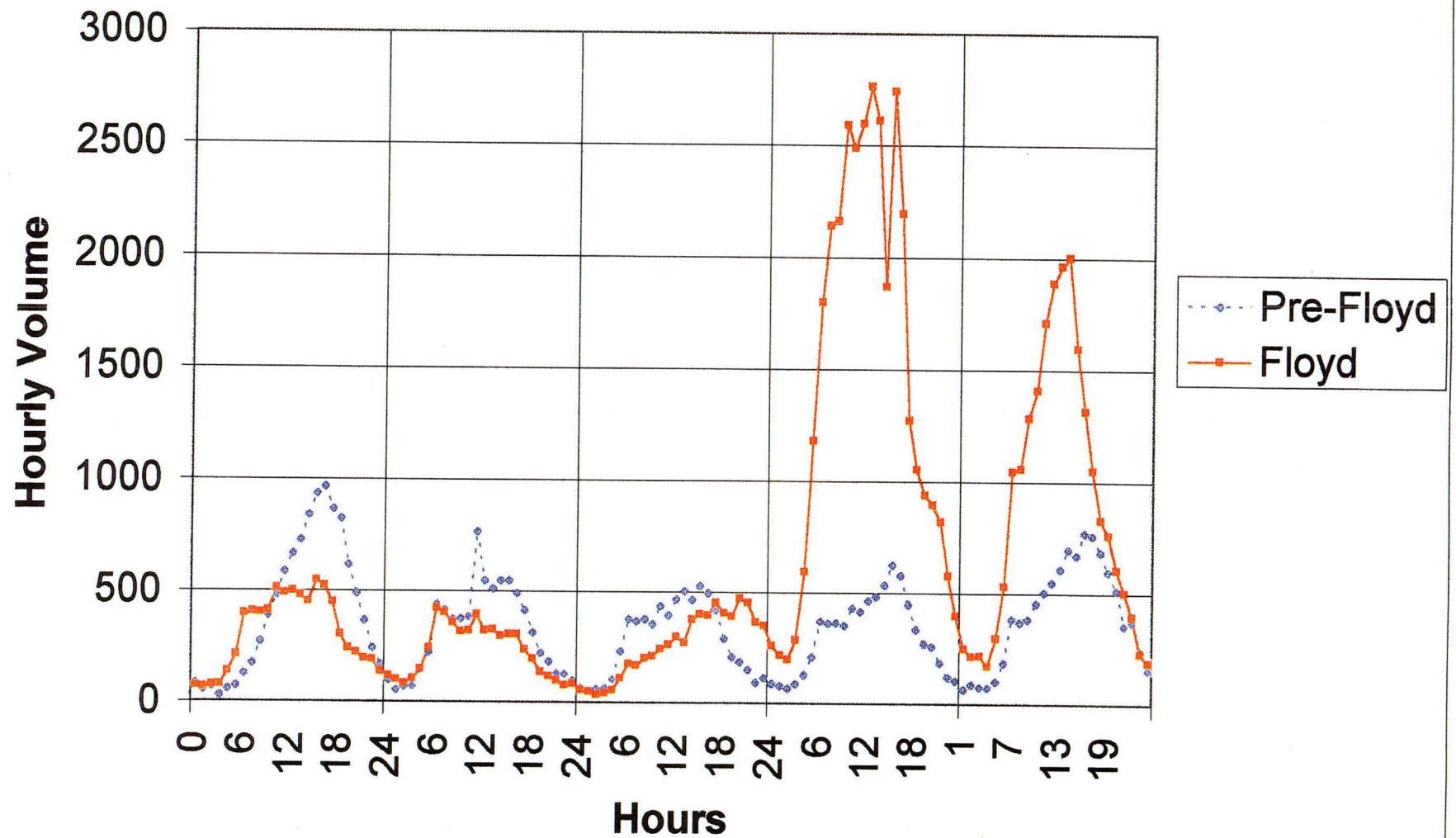
I-95 Northbound at Midway (Mon.-Fri.)



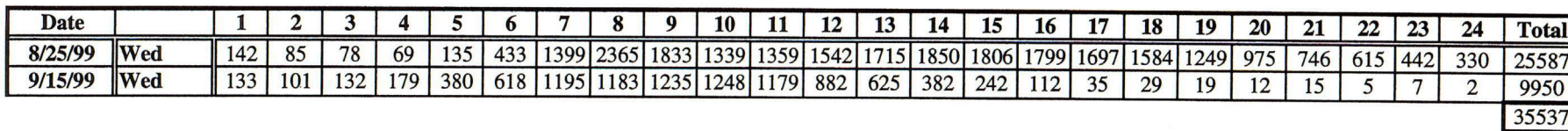
(Mon.-Fri.)



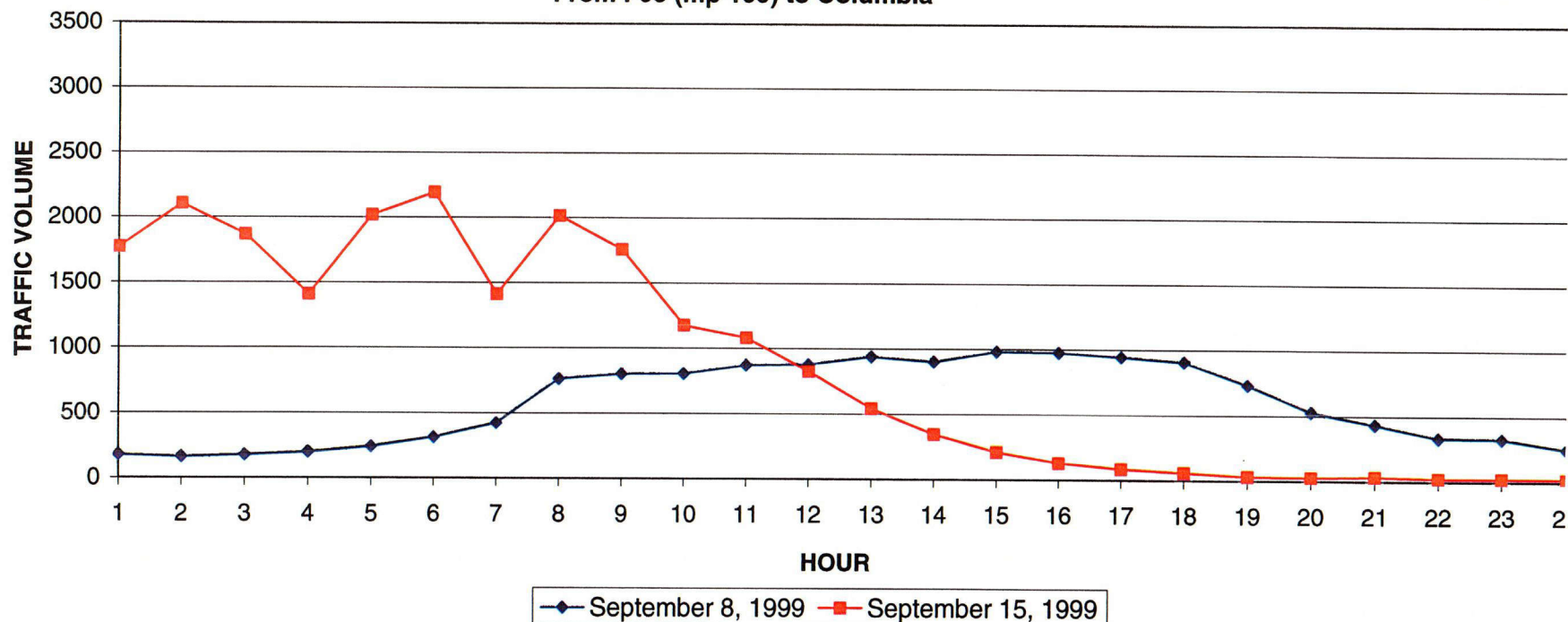
I-16 Eastbound at U.S. 441 (Mon.-Fri.)



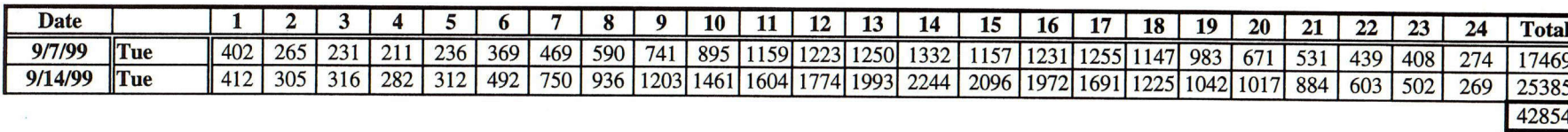
SOUTH CAROLINA TRAFFIC COUNTS



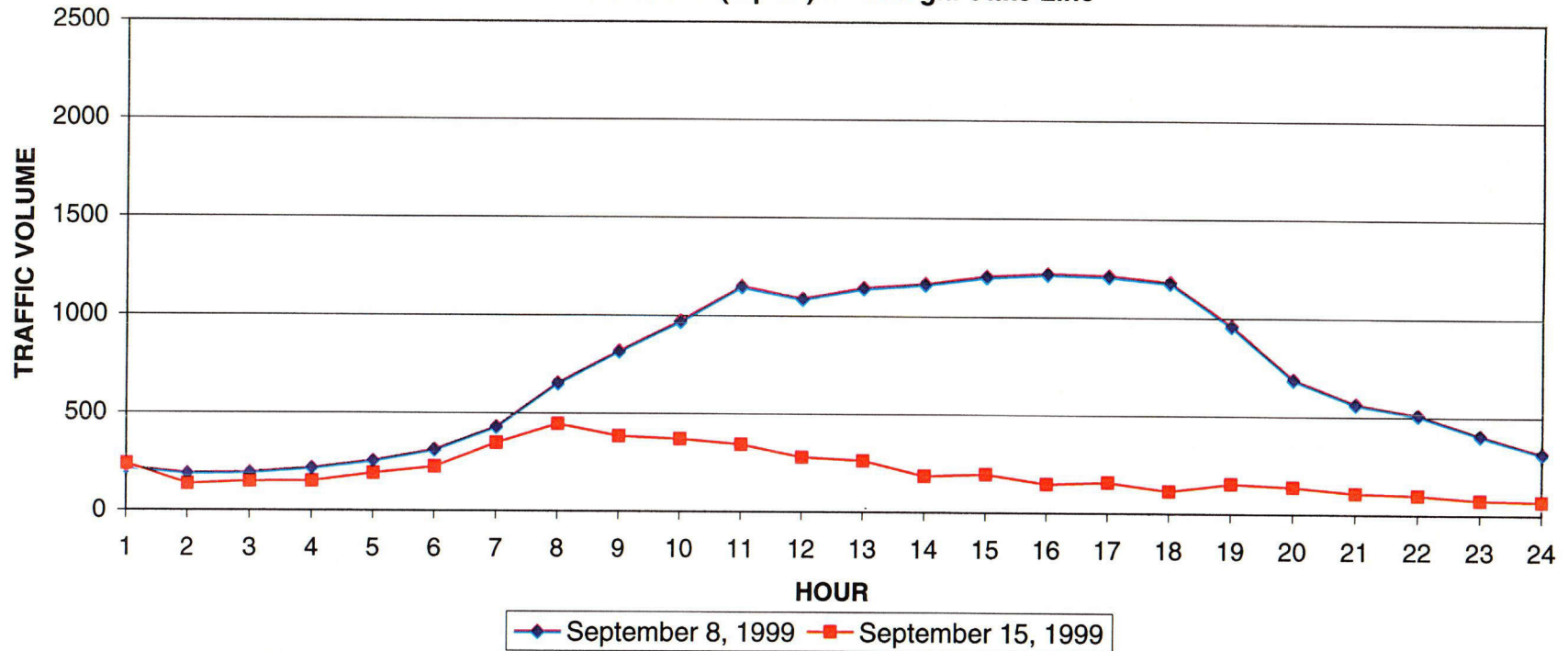
Sta. 20 I-26 W @ Bowman
From I-95 (mp 169) to Columbia



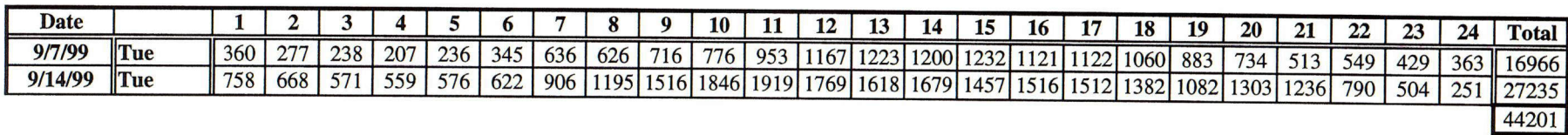
Date		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
9/8/99	Wed	176	161	177	198	242	313	424	764	801	806	873	881	940	903	982	975	946	907	734	527	432	332	326	249
9/15/99	Wed	1774	2106	1870	1410	2021	2195	1413	2015	1757	1177	1082	826	542	345	210	128	84	58	31	27	34	22	22	21



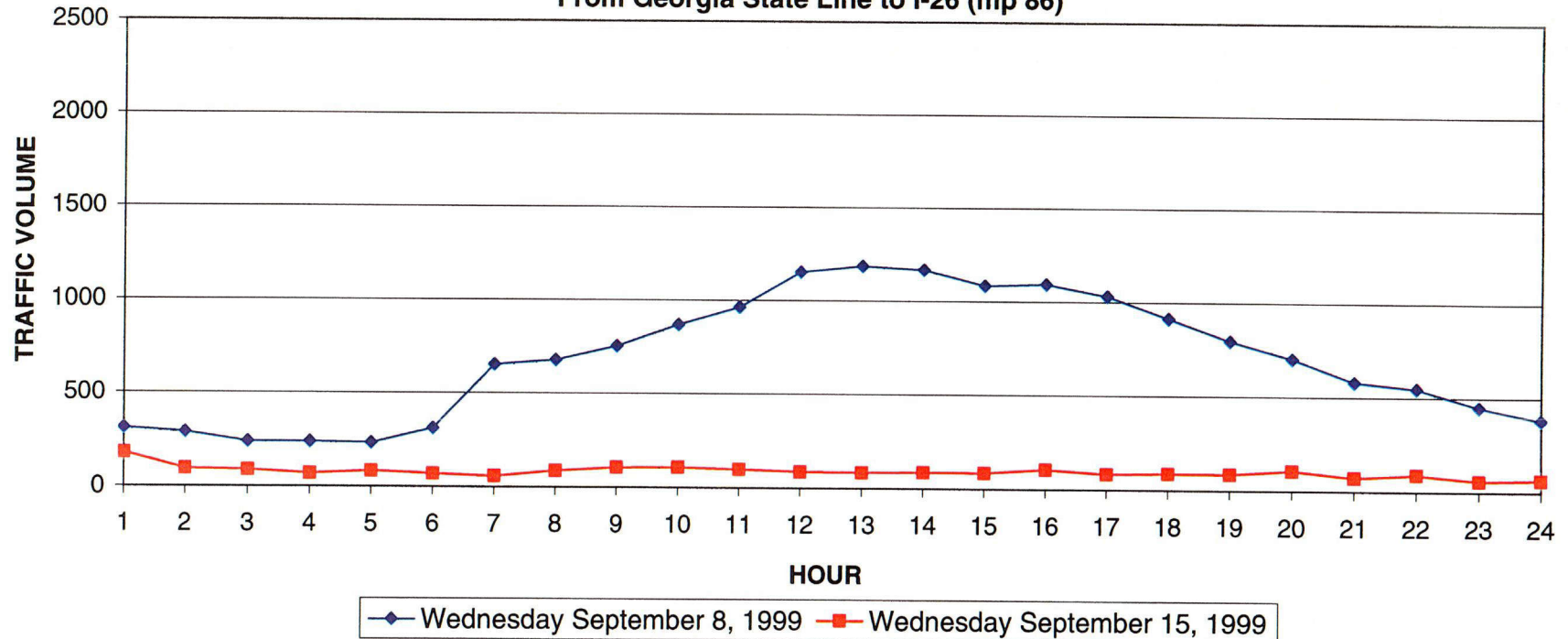
Sta. 28 I-95 S @ Georgia Line
From I-26 (mp 86) to Georgia State Line



Date		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Total
9/8/99	Wed	218	190	195	217	254	311	429	654	818	972	1149	1088	1143	1164	1203	1218	1210	1178	960	688	564	509	405	314	17051
9/15/99	Wed	235	133	146	147	188	221	345	443	381	368	340	275	259	182	193	145	155	111	150	136	105	96	72	67	4893

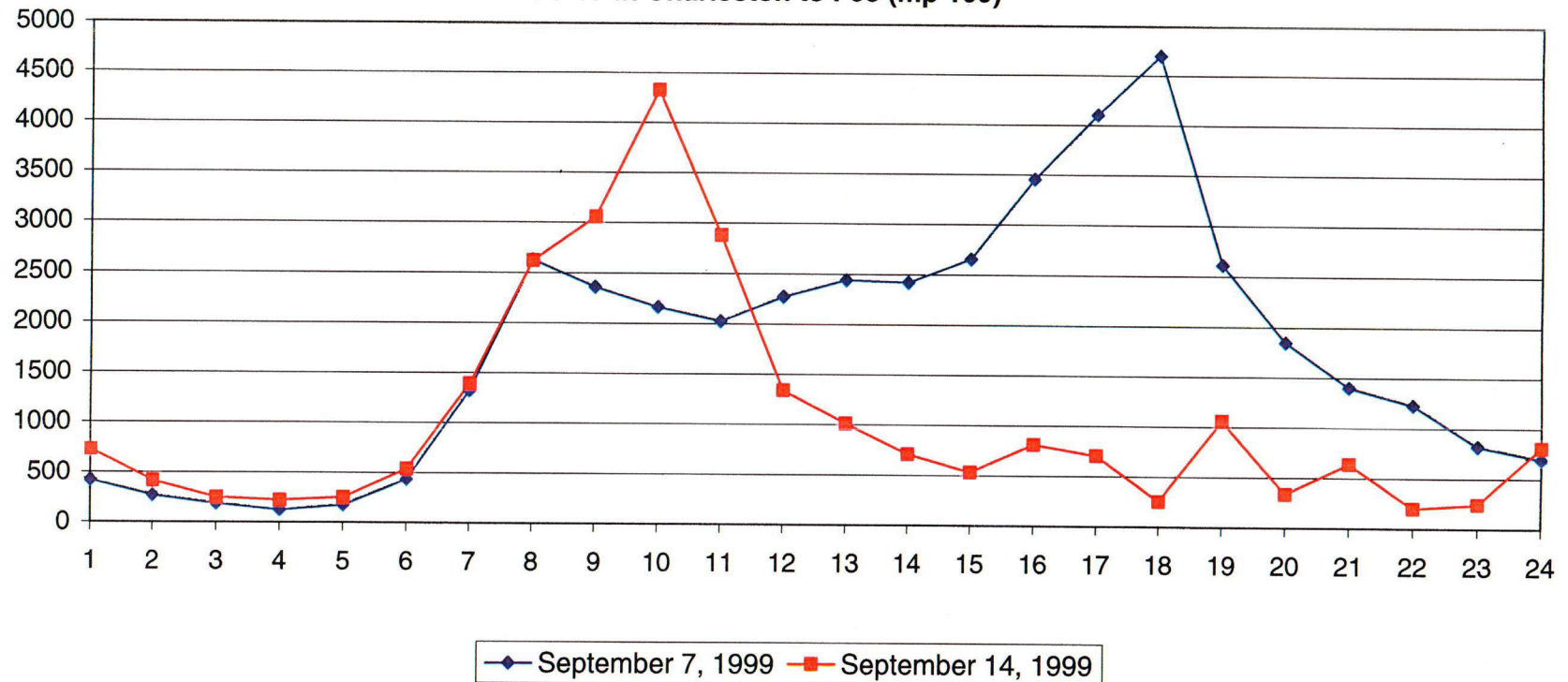


Sta. 28 I-95 N @ Georgia Line
From Georgia State Line to I-26 (mp 86)

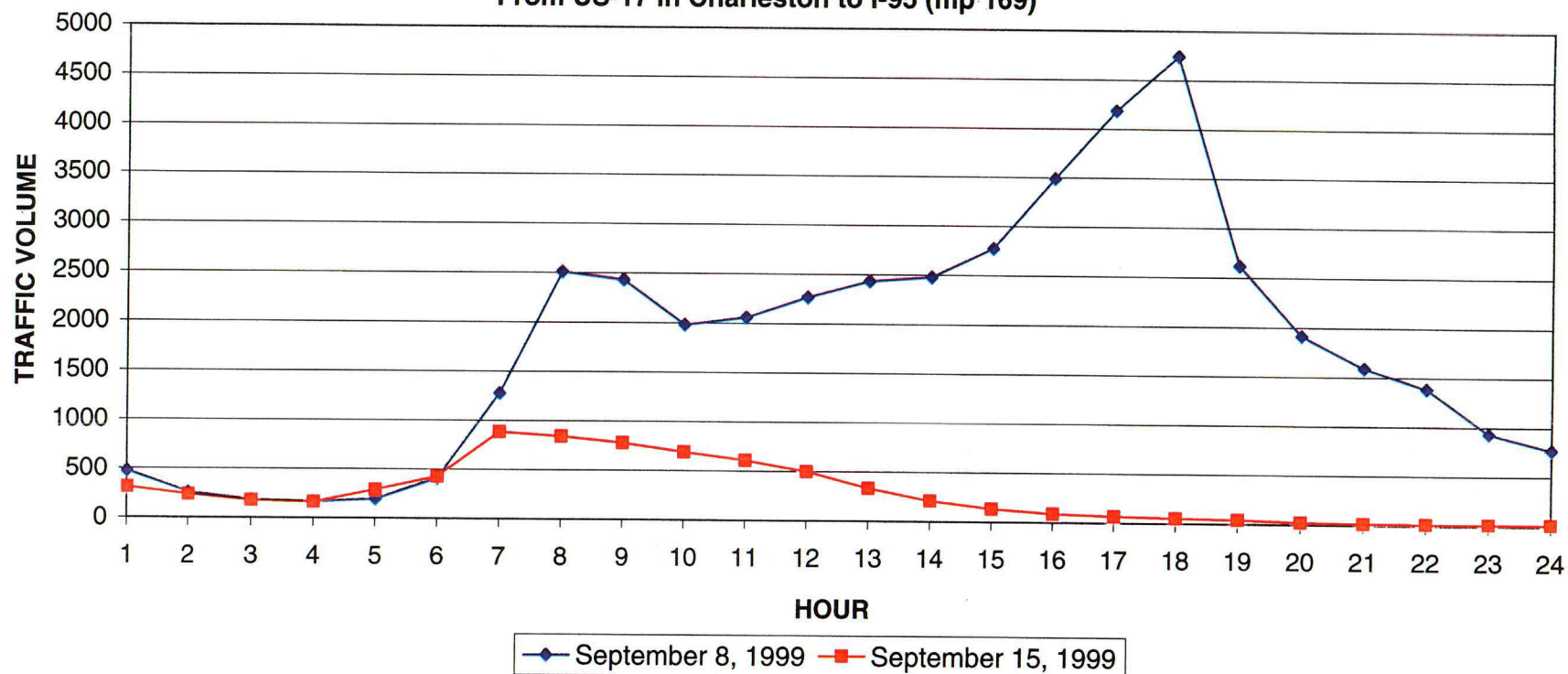


Date		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Total
9/8/99	Wed	311	289	238	239	233	310	653	678	753	870	963	1153	1187	1168	1085	1094	1031	915	796	703	581	548	449	381	16628
9/15/99	Wed	178	93	87	67	81	67	55	85	103	105	95	85	82	84	83	103	82	87	85	105	70	88	56	62	2088

Sta. 31 I-26 W (west of SC-642)
From US-17 in Charleston to I-95 (mp 169)

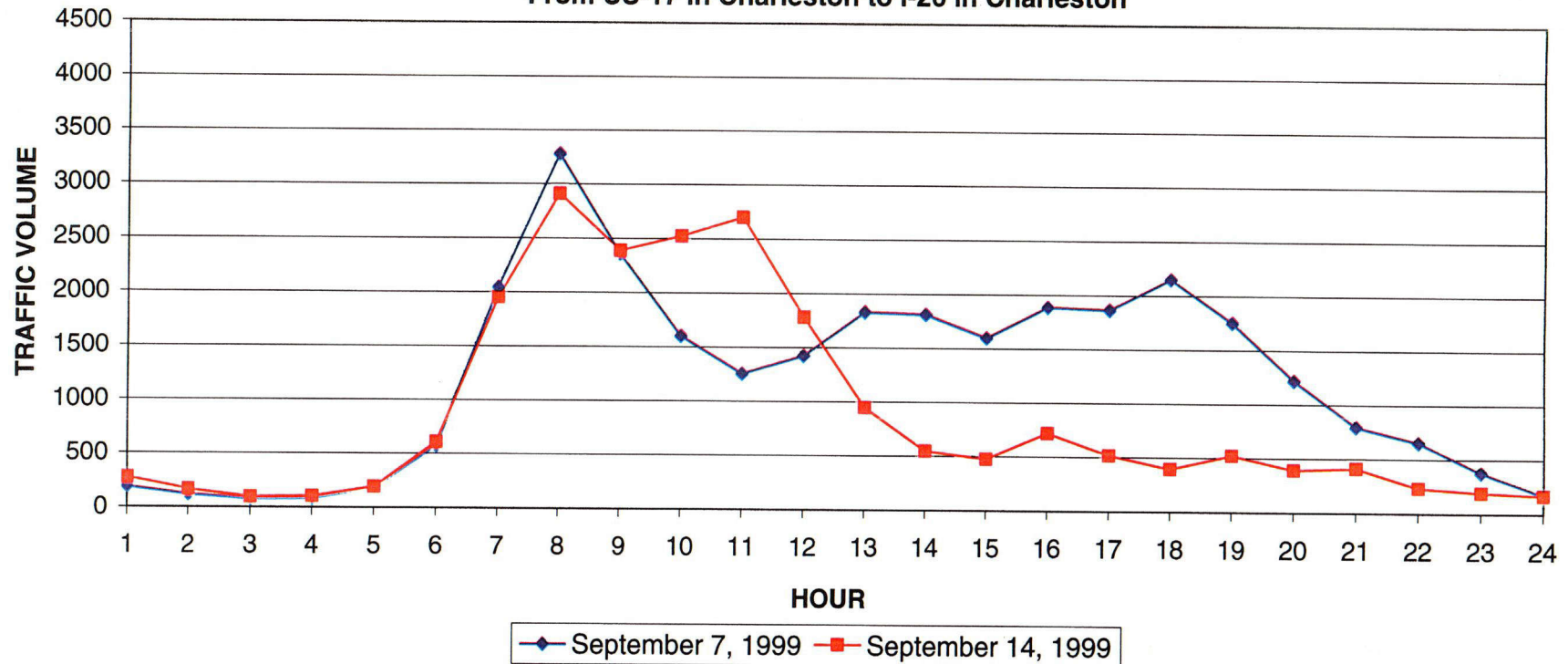
[illegible]

Sta. 31 I-26 W (west of SC-642)
From US-17 in Charleston to I-95 (mp 169)



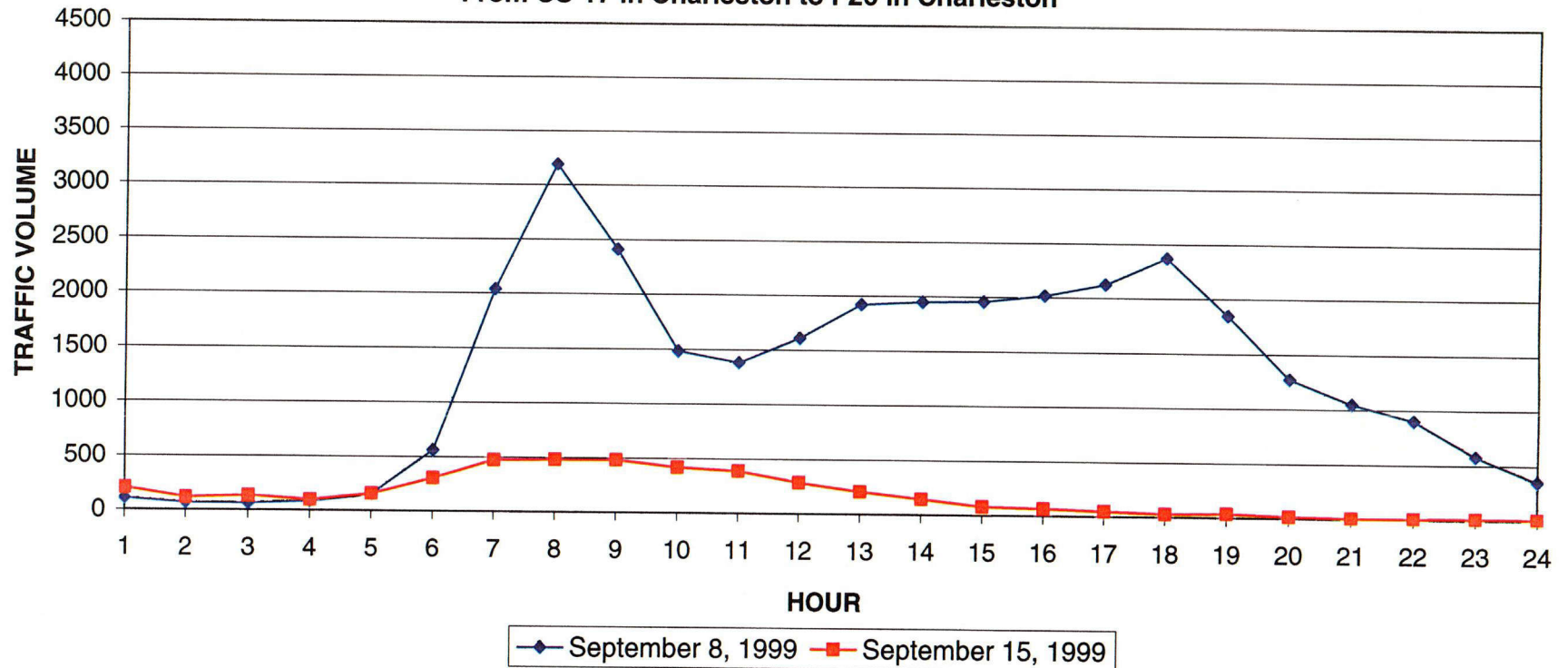
Date		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Total
9/8/99	Wed	473	258	182	165	194	408	1276	2509	2430	1982	2059	2269	2434	2480	2773	3488	4183	4739	2618	1912	1587	1383	930	768	43500
9/15/99	Wed	306	233	172	158	286	423	880	837	775	684	606	495	332	207	128	84	64	49	40	17	10	6	5	5	6802

Sta. 34 I-526 E (near SC-61)
From US-17 in Charleston to I-26 in Charleston



Date		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Total
9/7/99	Tue	193	122	80	89	193	579	2048	3278	2361	1602	1256	1423	1833	1813	1599	1888	1866	2149	1755	1222	795	654	378	176	29352
9/14/99	Tue	273	162	92	101	190	606	1947	2905	2382	2519	2695	1775	943	544	473	716	515	393	521	389	408	229	189	166	21133

Sta. 34 I-526 E (near SC-61)
From US-17 in Charleston to I-26 in Charleston



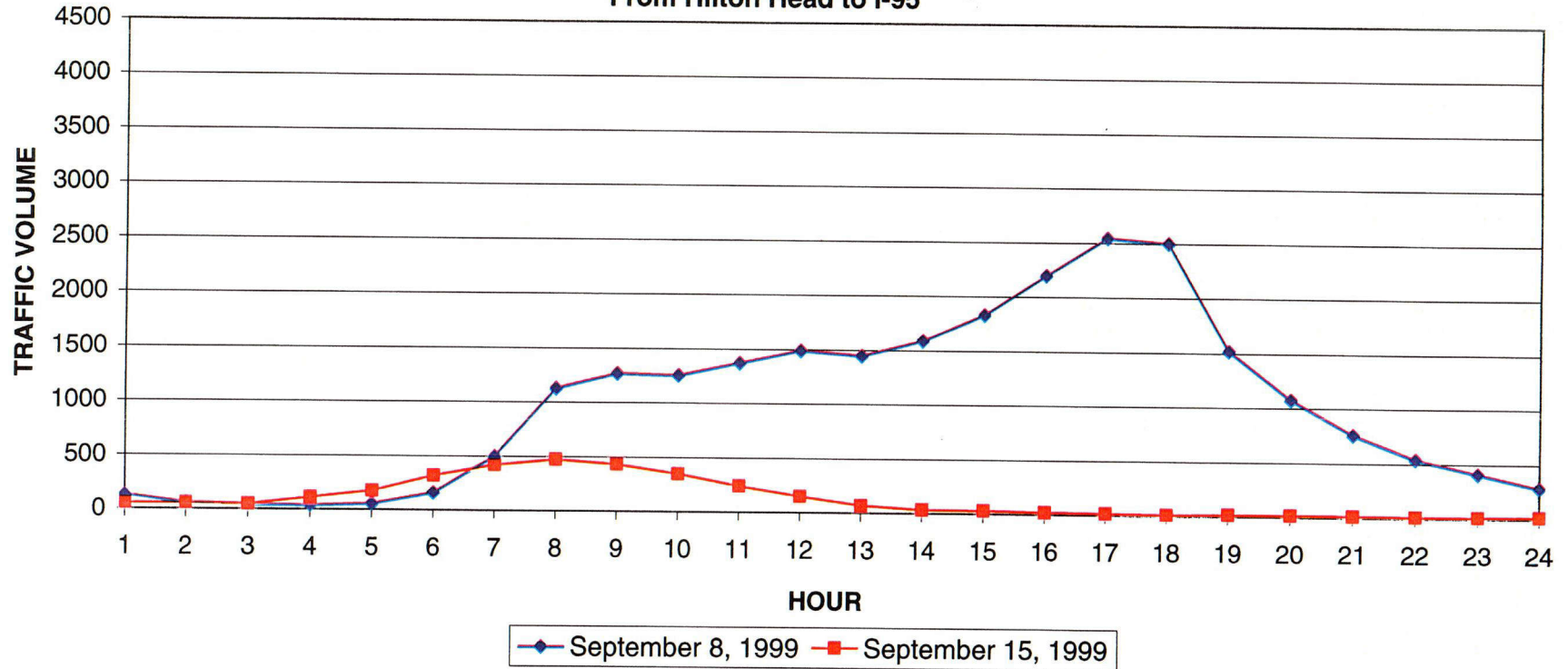
From Hilton Head to I-95



Date		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Total
9/7/99	Tue	121	61	42	58	92	201	559	1137	1328	1336	1475	1453	1565	1514	1863	2218	2431	2499	1586	942	582	489	374	260	24186
9/14/99	Tue	335	130	104	117	259	570	1026	1523	2374	2202	1777	1935	2216	2065	2330	1895	946	932	874	592	336	206	121	0	24865
																									49051	

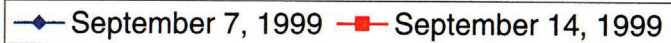
Sta. 35 US-278 W (west of Hilton Head)

From Hilton Head to I-95

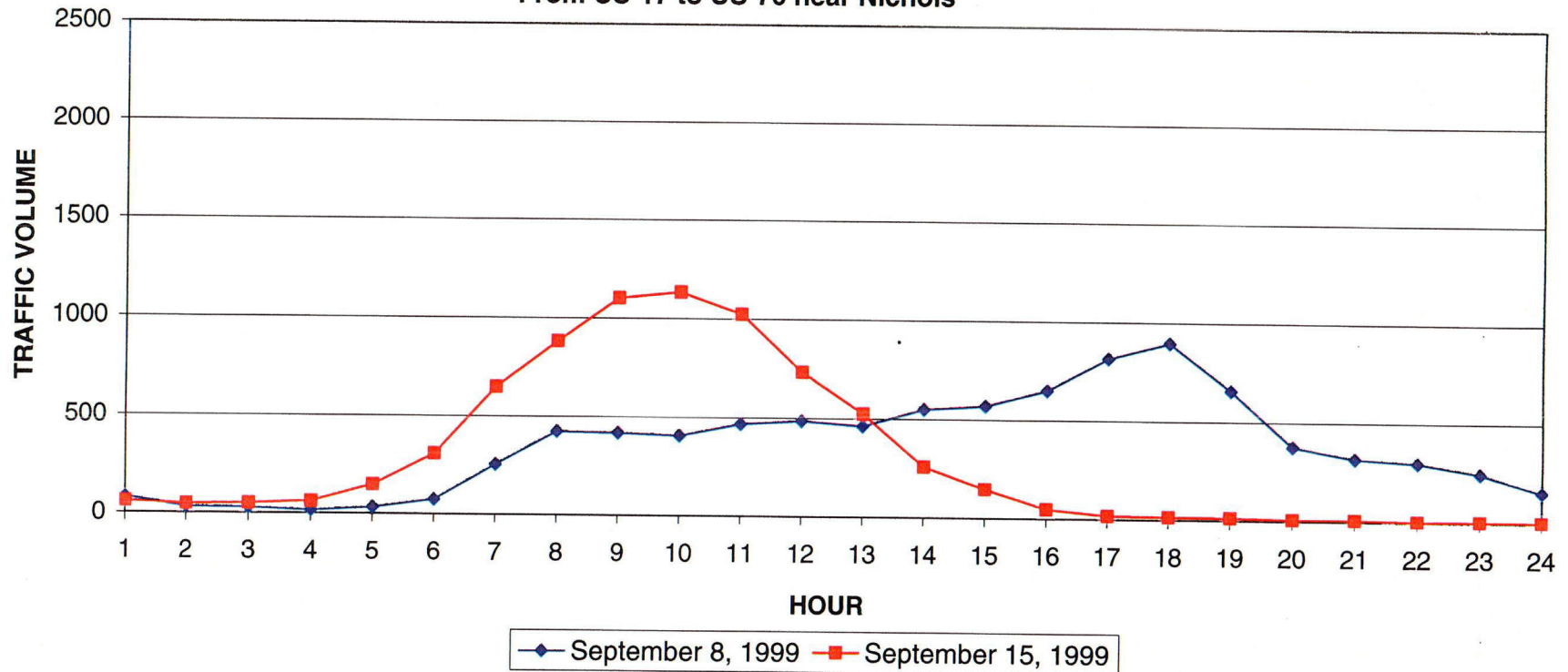


Date		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Total
9/8/99	Wed	133	59	42	41	56	161	503	1131	1272	1257	1375	1493	1452	1593	1833	2198	2548	2503	1522	1082	762	542	411	283	24252
9/15/99	Wed	51	51	44	108	171	314	416	469	430	344	236	144	65	29	28	15	11	3	10	12	8	6	6	12	2983

From US-17 to US-76 near Nichols

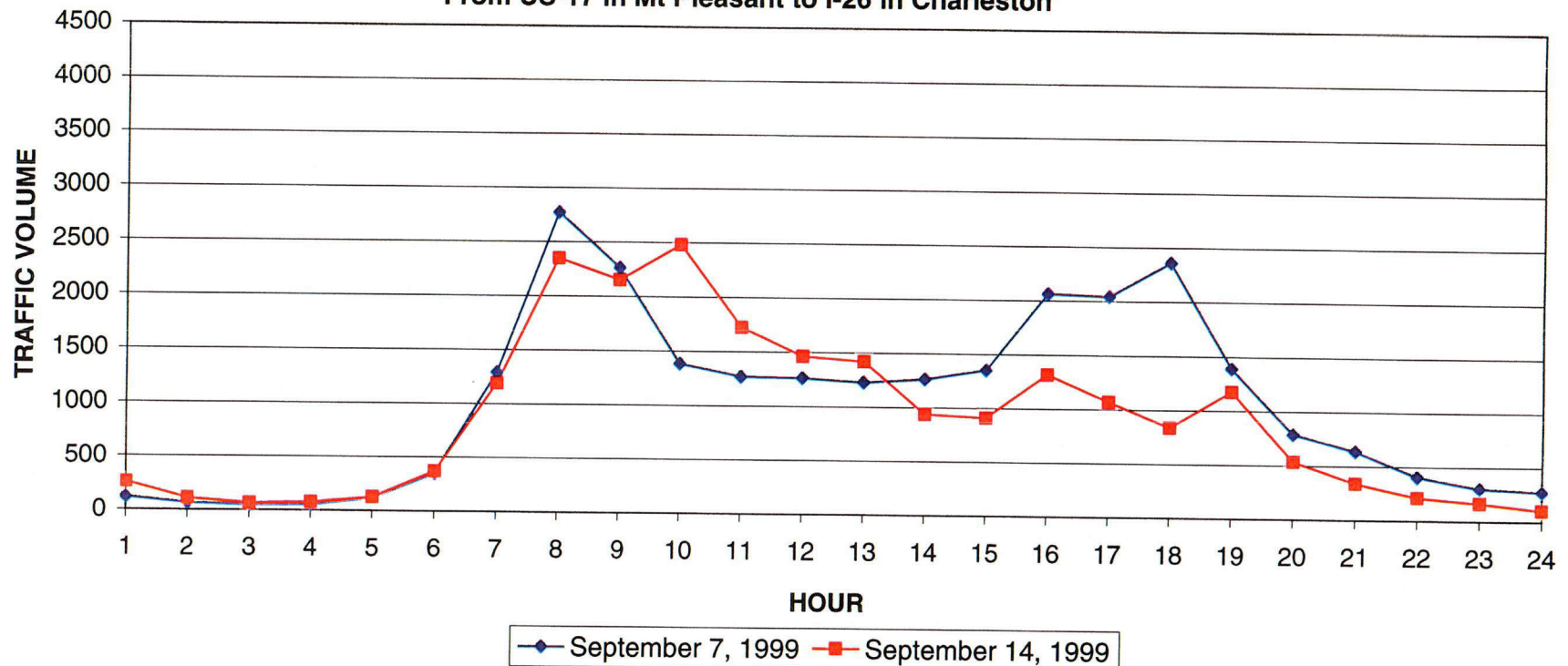
[illegible]

Sta. 36 SC-9 N (near Waccamaw River)
From US-17 to US-76 near Nichols



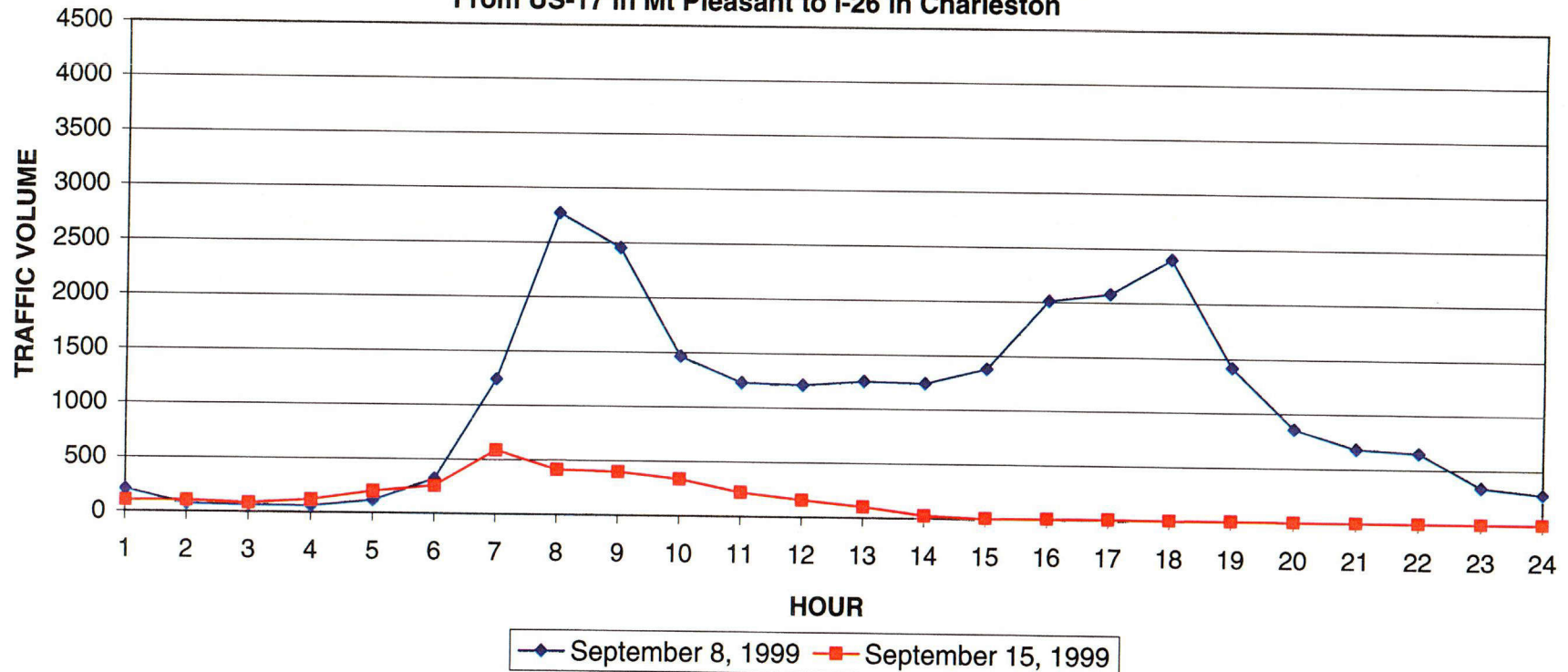
Date		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Total
9/8/99	Wed	84	32	28	16	33	74	257	426	420	408	470	487	463	551	570	651	817	897	658	377	319	299	247	154	8738
9/15/99	Wed	60	46	50	62	149	308	648	882	1103	1134	1024	733	525	259	148	48	18	15	14	7	7	1	3	2	7246

Sta. 46 I-526 W (in Charleston)
From US-17 in Mt Pleasant to I-26 in Charleston



Date		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Total
9/7/99	Tue	120	64	48	53	121	352	1291	2773	2267	1383	1269	1262	1227	1263	1350	2067	2045	2362	1388	787	639	406	302	276	25115
9/14/99	Tue	256	106	61	74	122	368	1186	2346	2148	2477	1723	1460	1416	935	908	1313	1066	835	1172	534	338	212	163	100	21319

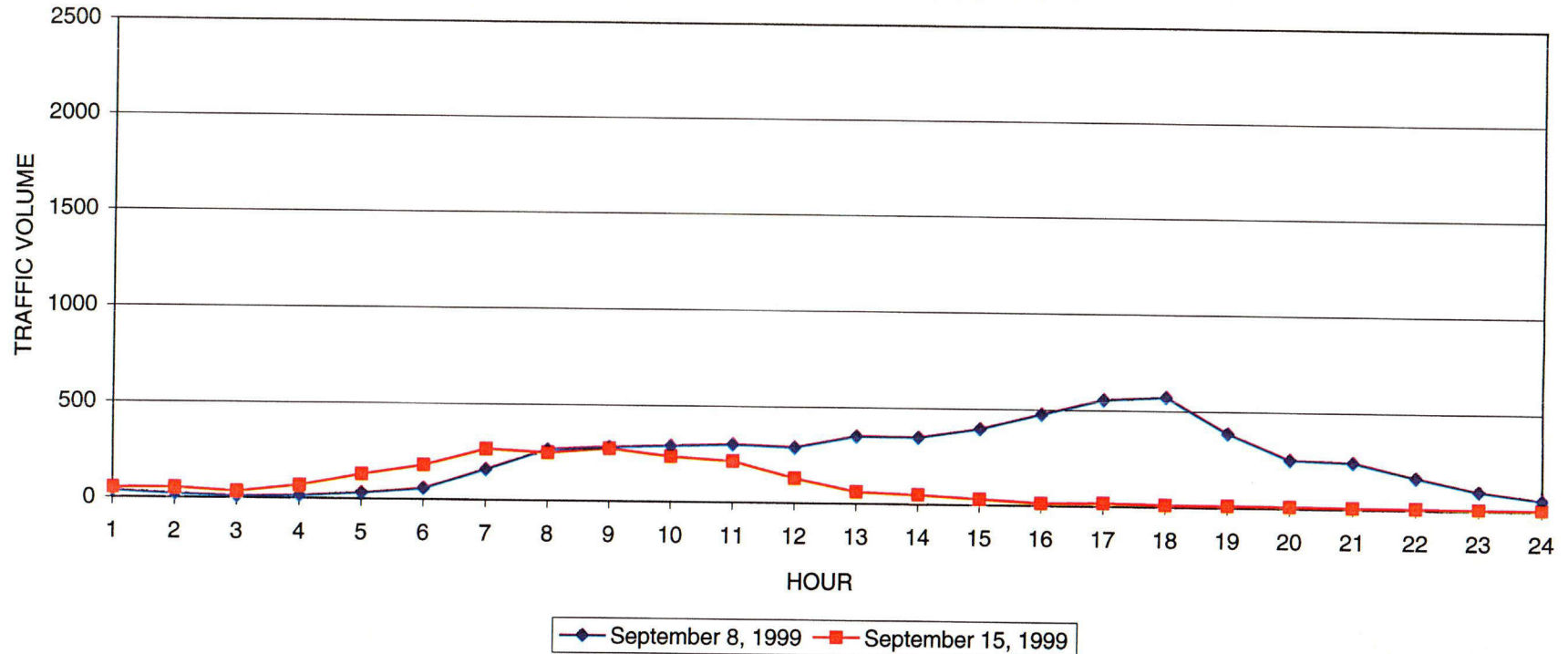
Sta. 46 I-526 W (in Charleston)
From US-17 in Mt Pleasant to I-26 in Charleston



Date		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Total
9/8/99	Wed	207	73	61	59	115	318	1238	2768	2454	1463	1228	1213	1252	1239	1378	2011	2079	2401	1417	859	680	648	338	280	25779
9/15/99	Wed	100	103	80	116	198	252	584	411	395	332	217	153	97	21	1	4	5	1	3	0	0	0	0	0	3073

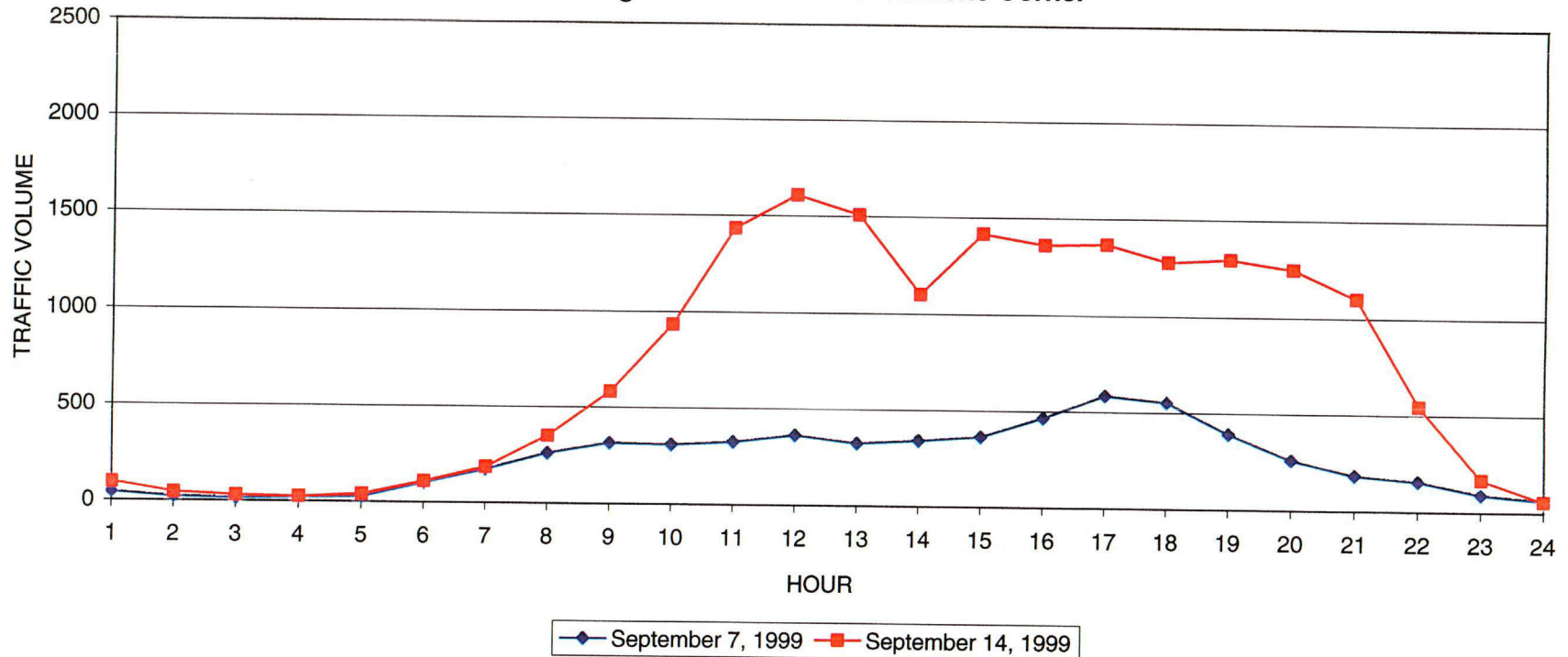
28852

Sta. 48 US-21 N (north of Beaufort)
From Hunting Island to US-17 @ Gardens Corner



Date		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Total
9/8/99	Wed	36	21	11	15	32	58	161	268	282	292	302	291	352	349	397	477	555	571	386	254	243	167	98	56	5674
9/15/99	Wed	51	52	34	67	127	177	264	247	272	234	212	127	60	48	29	10	16	9	9	8	5	5	1	1	2065

Sta. 48 US-21 N (north of Beaufort)
From Hunting Island to US-17 @ Gardens Corner



Date		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Total
9/7/99	Tue	44	22	15	22	27	103	175	261	316	309	326	363	324	341	364	465	585	552	392	261	184	156	91	63	5761
9/14/99	Tue	97	45	31	25	40	109	186	349	582	932	1433	1607	1507	1099	1414	1359	1365	1277	1294	1245	1098	543	167	56	17860

NOAA COASTAL SERVICES CTR LIBRARY



3 6668 14117423 7